POWER

Vol. 37 NEW YORK, APRIL 15, 1913 No. 15

ANSWERING THE CALL OF INDUSTRIAL DISTRESS

Condensing Equipment of Lake Shore Plant

By A. D. Williams

SYNOPSIS—A general description of the Lake Shore plant of the Cleveland Electric Illuminating Co. appeared in the Mar. 18 issue. The present article deals with the intake and discharge conduits and basins, the surface condensers and the condenser auxiliaries.

The base condensers in the Lake Shore plant are of the two-pass type, the exhaust from the turbines flowing into them through free annular openings. The vapor and condensate both flow downward, the condensate collecting in a well from which it is drawn off and pumped to the feed-water heaters by a volute pump. The air or dry-vacuum pump suction is located close to the tubes of the first or coldest water pass in order to avoid the use of a precooler for reducing the density.

Lake Erie, which furnishes the circulating-water supply, is subject to very slight fluctuations in level and whatever current there is has a slight set toward the east, except when infrequent easterly storms set up surface currents flowing toward the west. To separate the intake and discharge water, an intake channel, formed by two parallel moles of concrete, has been built out into the lake at the west end of the plant. These are of extremely heavy construction and the entrance to the channel is obstructed by piling to prevent blocking of the channel by the heavy ice flows in the spring. The pier on the east side of the channel has a right-angled turn, parallel with the front of the building, and forming a basin divided in two sections by a wall of sheet piling tied together at the top. The section of the basin immediately alongside of the building forms the intake forebay from which the cooling water is drawn. The discharge pipes, in pairs, pass under this forebay and, rising close to the surface, discharge into the outer basin. Connecting gates are placed at the west end of the outer basin so that the warmer water from the condensers can be discharged into the intake forebay to prevent the formation of ice in extremely cold weather.

Each intake is provided with four screens, arranged in two sets, each set consisting of two screens in series, so that any screen may be raised for cleaning without interrupting the flow of water to the condensers. In addition there is a gate frame at the mouth of the conduit so that it can be closed off and pumped out, if necessary for cleaning or inspection. The mouth of the discharge can be closed by stop logs or needles, when necessary.

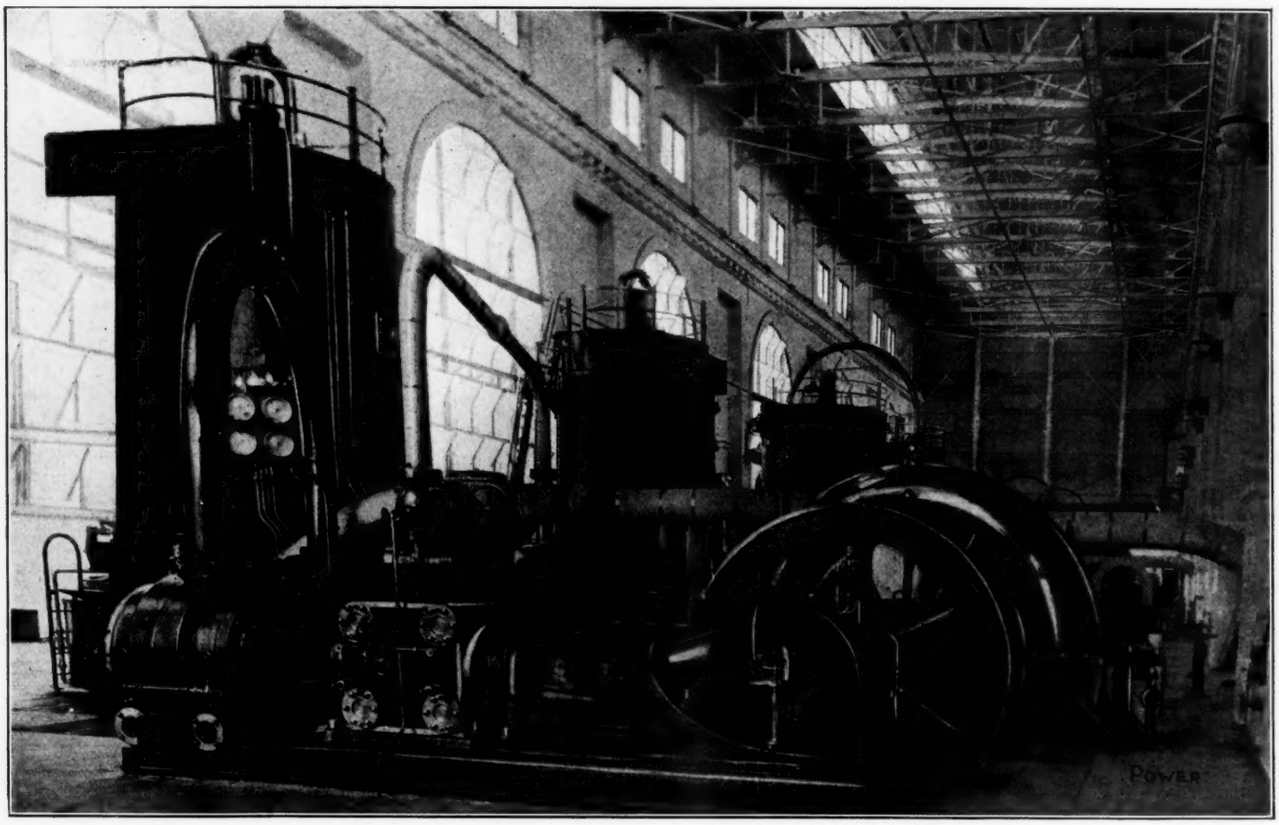


Fig. 1. Dry Vacuum and Circulating Pump for Unit No. 1

The intake and discharge conduits are 5 ft. in diameter and of reinforced concrete. The intake is above the discharge for the same unit and the conduits for each group of two units are run in the same trench. Inside the building the discharge conduits turn out and up, as shown in the plan, forming the discharge well. The intake conduits continue to the other side of the basement, where they turn to join the intake well. The bottoms of these wells are 16 ft. below the level of the lake and the circulating pump-suction pipes are submerged 5 ft., the discharge draft tubes having the same depth.

In each case the dry-vacuum and the circulating pumps

have been combined in a single Corliss engine-driven unit. The load on the circulating pump is confined to the friction head of the cooling-water piping and the power required to maintain the column of water in motion. The starting head, however, corresponding to the power required to set the column of water in motion, is considerable and this occurs when the load on the dry-vacuum pump is at a minimum; hence, considerable economy results from combining the two in one unit. The circulating pump is of the single-stage type with double-suction pipes, its center line being about 16 ft. above the normal level of the lake and about 8½ ft. above the center of the condenser, to which it is connected by a special offset bend. This arrangement of piping permits all of the auxiliary apparatus, except the condensate pump, to be located upon the main floor of the turbine room. At the same time it slightly increases the suction lift in starting and the friction head in operating.

The suction pipe of the air cylinder connects with the coolest portion of the condenser and forms a large radius bend to the top of the cylinder. These pipes are of large size to minimize friction losses, and the exhaust is carried into the free exhaust line just outside of the back-pressure valve. Flash ports are provided for equalizing the pressure in both ends of the cylinder at the commencement of each stroke and the ends and barrel of the cylinder are water jacketed.

The hotwell pumps are placed in pits below the level of the basement floor. They are connected to the hotwell by large suction pipes and the highest point in their casing is vented back to the condenser to prevent their becoming vapor bound. The discharge is piped to the feed-water heaters from which it is drawn by the boiler-feed pumps. These pumps are single-stage centrifugals driven by small steam turbines. The exhaust steam from the condensing equipment, together with that from all of the other auxiliaries is delivered to the feed-water heaters.

Each unit is provided with a free exhaust back-pressure valve and an independent atmospheric exhaust line.

CONDENSING DATA

	Wheeler Units Nos. 1 and 2	Alberger Units Nos. 3 and 4
Rated capacity of generating units, kv.-a.	9000	14,000
Steam pressure, lb. per sq.in.	215	215
Condensers—nominal vacuum in inches of mercury	28.00	28.60
Pressure, lb. per sq.in.	0.980	0.686
Circulating water—initial temperature deg. F.	70.00	60.00
Square feet of cooling surface, per condenser	16,000	25,000
Square feet of cooling surface per kv.-a.	1.777	1.785
Number of 1-in. tubes in condenser	3592	5620
Nominal capacity of condenser,		
Pounds of steam per hour	140,000	224,000
Pounds of steam per square foot of cooling surface per hour	8.75	8.96
Pounds steam per hour per kv.-a.	15.59	16.00
Number of water passes in condenser	2	2
Velocity of cooling water in tubes, ft. per min	....	450
Cooling water pumps—double-suction, single-stage		
Diameter of discharge, inches	30	36
Nominal capacity, gal. per min.	24,000	30,000
Pounds of water per minute	200,169	250,000
Pounds of water per pound of steam	85.80	67.47
Speed of cooling water pump, r.p.m.	65–110	100–150
Circulating water intake and discharge		
Diameter of conduit, ft.	5.00	5.00
Bottom of intake and discharge pipes below normal lake level ,ft.	8.5	
Bottom of suction and discharge wells below normal lake level ft.	16.0	
Submergence, suction and discharge pipes, normal lake level, ft.	5.5	
Height of center line of cooling water pump above normal lake level, ft.	16.00	
Variations in lake level—		
Above normal, ft.	1.85	
Below normal, ft.	1.15	
Approximate velocity of flow in conduits, ft. per sec.	2.73	3.40
Hotwell pumps—centrifugal, single-stage		
Suction, diameter inches	8	6
Discharge, diameter, inches	4	5
Capacity, gal. per min.	300	675
Pound of condensate per hr.	150,000	337,500
Speed, r.p.m.	2,000	2,200
Motors, Terry steam turbines.		
Dry vacuum pumps—single-stage with flash ports—		
Air cylinder, in.	30x18	34x24
Steam cylinder, in.	16x18	20x24
Speed, r.p.m.	75 to 110	100 to 150

The condenser for unit No. 5 is similar to those for units Nos. 3 and 4

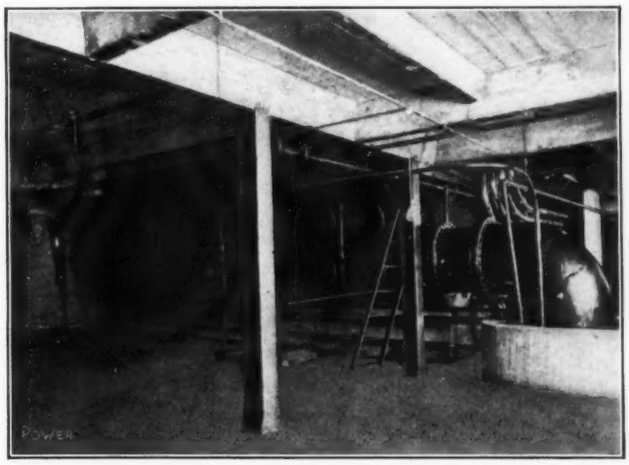


FIG. 3. SURFACE CONDENSERS

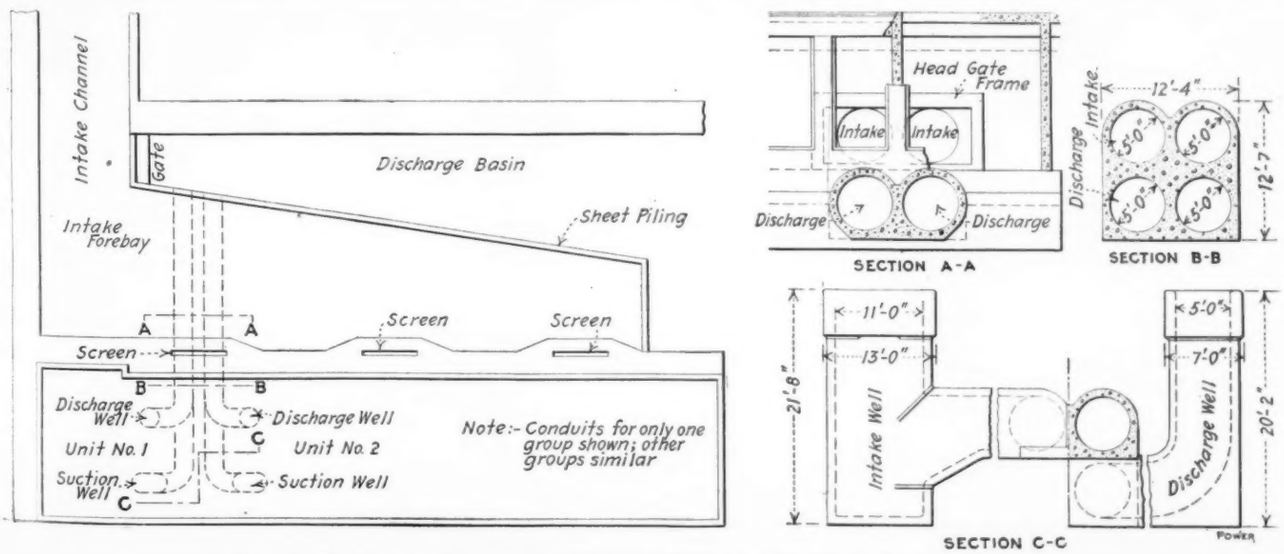


FIG. 2. PLAN AND SECTIONS THROUGH INTAKE AND DISCHARGE TUNNELS

Stresses in Unsymmetrical Boiler Joints

SYNOPSIS—Account of an experimental investigation of the above subject, conclusions of which were that the maximum fiber stresses may be two to four times those for which the joint was designed, that most joint failures are due to unsymmetrical design, that boiler parts subject to bending action particularly should be inspected for incipient cracks and that pitting should be watched as likely to start cracks.

A paper of interest to all concerned with the question of the failure of lap boiler joints, in the manner commonly known as "lap-joint cracks," was presented to the Engineering Association of New South Wales, by S. H. Banaclough and A. J. Gibson.

The paper is in two parts: The first deals with the explosion of two locomotive boilers constructed with lap joints, discussing the theory of the action of a lap joint under pressure and the probable cause of the formation of the so called, lap-joint cracks. The second part recounts an extended series of tests which show the actual maximum fiber stress as determined by measurement of the strains in the plate adjacent to the joints.

One of the explosions consisted of the upturning of the outer side plate of the furnace of the locomotive boiler, constructed with a separate sheet to form the wagon top, instead of a continuous wrapper sheet. The side sheets were lapped outside of and joined to the top sheet by double-riveted lap joints. The fracture started from the inner surface of the side sheet and closely followed the edge of the top sheet, working its way toward the outer surface until the sheet was so weakened that it upturned under the usual pressure, 140 lb.

The fractured joint was at, relatively, a short distance above the stay-bolted surface. This fracture was 40 in. long and extremely straight. At each end of it, near the head and barrel joints, were numerous small cracks and to open them for examination the sheet was bent down at the corners with hydraulic pressure. A close examination before bending, indicated that they were small cracks and groovings. Some appeared as shallow grooves—about $\frac{1}{32}$ in. deep and $\frac{1}{16}$ in. wide, and had the appearance of marks made by a blunt chisel but in no way resembling serious cracks. Bending the plate back, however, showed a crack at the bottom of these grooves which extended about one-third through the plate. A microscopic examination indicated that all the cracks originated as grooves with well rounded edges and at the bottom of the grooves were fine hairline cracks.

Fig. 1 shows how the cracks are supposed to develop. The fractured plate was of low moor iron $\frac{9}{16}$ in. thick and results of physical tests of seven different samples taken from various parts of the plate averaged 49,658 lb. per sq.in. tensile strength, with a 27.1 per cent. reduction in area at the fracture and 16.1 per cent. elongation in 8 in. These figures represent good average quality and normal ductility for this material.

Bending and twisting tests showed that the grain of the material ran at right angles to the joint line, as it should. Having, practically, eliminated, by these tests, the quality of the material as a factor in producing the cracks, it was observed that such cracks occur only at joints where the surface strains are very variable and abnormally high. It is shown by a method of movements that in a riveted joint, formed by lapping two plates of equal thickness, when it is subjected to a straight pull tending to separate them at the joint, the maximum fiber stress along the two surfaces in contact will rise to a point where it equals four times the stress produced by the direct pull on the plate. Also, the opposite surface may have a compressive stress, in the vicinity of the joint, of twice the amount of the direct pull.

These conclusions were verified by tests described in the second part of the paper. It is pointed out that this maximum stress cannot occur along the part of the joint directly between the rivet holes, which constitutes the net section of the plate and is the section always used as a basis for determining the strength of the joint as far as the plate is concerned. It is also noted that the particular form of the joined ends of the plates, with respect to the true cylindrical shape of which they are assumed to form a part, will have a material bearing on the maximum surface stress that may be produced in the plates.

Examination of the corresponding joint on the other side of the boiler seemed to indicate the possibility of a pitting action or fracture at one point in its length and the rivets were removed and the plates separated.

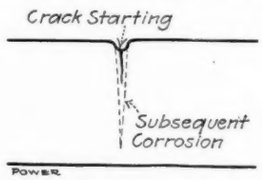


FIG. 1. HOW CRACKS GROW

The surface which had been covered by the lap of the other plate indicated some slight pitting or grooving along the line that had been occupied by the edge of the underlapping plate, but nothing that would suggest that the plate was not as good as new.

Subsequently, the entire plate was removed from the boiler and the part which had formed the joint was placed under a hydraulic press to develop any incipient cracks that might not have become visible. This showed that the plate was cracked almost its entire length and, practically, through to its outer surface, similar to the sheet which had caused the explosion.

The second exploded boiler was of steel plate $\frac{3}{8}$ in. thick. The fracture followed the line of rivet holes. It was along one of the seams of a barrel course and occurred in the underlapping plate, the one to which the boiler dome was attached. Physical tests of two pieces of this plate, taken from near the rupture and at right angles to each other, showed an average tensile strength of 62,426 lb. per sq.in. and contracted in area 48.2 per cent. and elongated before fracture to 24.2 per cent. in a length of 8 in.

The fractured plate showed that most of the holes had been punched full size and numerous small cracks were observed around the rivet holes; these being attributed to injury done the metal in punching the holes, as no defect was shown in the quality of the material by the physical test. It is pointed out, that, no matter whether

it is the underlying or overlapping plate which cracks, the fractures always commence on the surface whose fibers are subjected to the highest tensile stress and they work toward the surface of compression or low tensile stress. If the conclusions regarding the formation of lap cracks due to high surface tension along certain lines parallel to the joint, are correct, it is pointed out that similar unusual stresses will be developed in other parts of a boiler where the form tends to produce unsymmetrical loading of the parts. Such parts are dished heads, and parts of the shell adjacent to reënforcements similar to those used around manhole openings or for the attachment of valves or other fittings.

The general conclusions at which the authors arrived were as follows: The failure in each case was due, primarily, to the high surface stress which is characteristic of all places lap-joint cracks occur. The failures were not due to any defect in the quality or structure of the material of the plate.

High proof-pressures should be avoided on boilers, especially old ones, since they only tend to aggravate the trouble.

Much valuable information might be obtained by a close study of the plates in the neighborhood of riveted joints when old boilers are being broken up. The closest scrutiny should always be given to boilers with lap joints, and, especially, to their joints. No suspicious signs in lap joints should ever be neglected and the internal in-

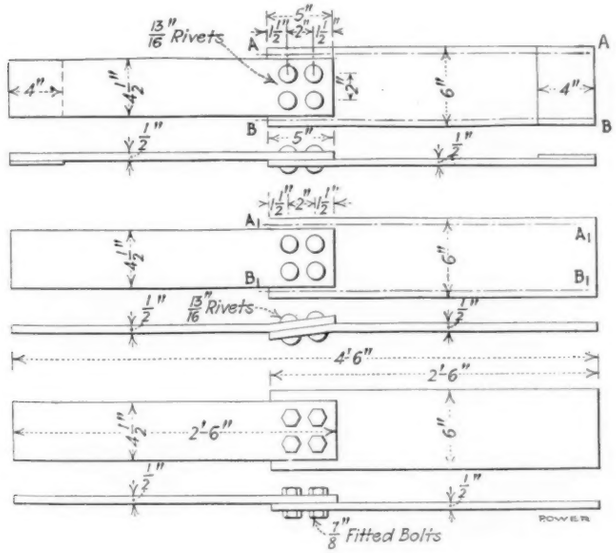


FIG. 2. EXPERIMENTAL LAP JOINTS

spection of lap-jointed boilers should be more frequent than when fitted with butt joints. Above all, the conclusion is that riveted lap joints should not be employed under any circumstances in boiler construction.

TESTS SHOWING MEASUREMENTS OF STRAINS IN BOILER JOINTS

The second part of this paper describes three series of tests of lap joints, both in testing machines and in actual construction, where an internal pressure is used to produce the loading of the joints. For the machine tests, three samples were made up, as shown in Fig. 2, and these had varying loads applied to them by a testing machine as will be described later.

The first test joint was made up of straight plates riveted together. The second had the plates already formed (adjacent to the joint) to the position which they would tend to occupy under a load acting to pull them apart. The third test piece was made like the first, except that turned bolts were fitted in the holes in place of rivets. One of the plates forming these joints was wider than the other. This construction was used so that the joined surface of one of the plates might be available for measurements throughout its entire length. In the tests, measurements were made of the extension of the fibers on the surface of the side plates along the test lines AA—A_1A_1 and BB and B_1B_1. Since the extension of these fibers is proportional to the others (within the elastic limit) such

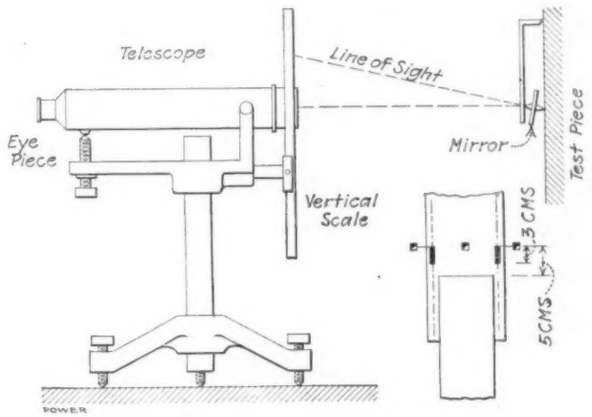


FIG. 3. FIG. 4

MARTENS MIRROR EXTENSOMETER AS ORIGINALLY EMPLOYED

measurements would indicate the relative stress at the different joints at which the measurements were made for the various loads applied.

The measurements of the surface extension along the test lines were made with a Martens mirror extensometer, shown in Fig. 3. This consists of a bar held at one end of a fixed joint on the test piece and with the other end resting on a prism to which a mirror is attached and one side of the prism also rests on the test piece. Any change in the length of the surface of the test piece between the two points upon which the bar and prism rest will tend to rotate the prism and, therefore, the mirror, and measuring of the angle through which it is rotated, indicates the relative amount of extension. To prevent displacements of the test piece as a whole from affecting the readings, additional mirrors were attached directly to the test piece in line with the extensometer mirror, as shown in Fig. 4.

The elimination of the effect of all movements of the surface carrying the extensometer, other than its elongation under strain, was difficult as the surface of the plate under test tended to rotate in the vicinity of the joint, due to the bending action produced by the change of form. In the first series of tests, this was cared for by attaching a mirror so as to indicate the amount of rotation of the surface upon which the prism of the extensometer rested.

Readings were taken at seven different positions along the test lines AA and BB, Fig. 2; the loads on the test pieces being raised from 0.2 to 3 tons by increments of 0.2 ton each. Curves were drawn from the results obtained at each test joint by plotting the mirror readings

against the loads producing them. In each test the maximum load was applied twice at readings taken at the various loads, both with the load ascending and descending. Fig. 5 shows a complete set of readings for one test point and the line represents the average. The values, represented by this line of average, were used instead of the individual readings as an aid to accuracy.

From a set of diagrams like Fig. 5 (made up from the tests at various points along the surface of the test piece) values were selected corresponding to a load of three tons

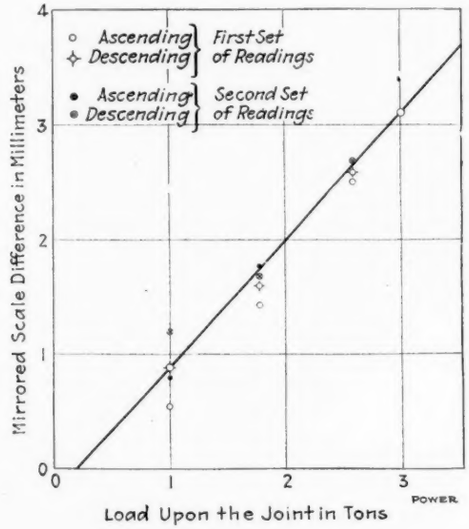


FIG. 5

and a strain diagram, as shown in Fig. 6, constructed. The upper part of this curve indicates, by its relative distance above line *OA*, the varying strain in the fiber along the surface of the plate at *AA*, and the line parallel to *OA* passing through *C* indicates, by its distance above *OA*, the estimated amount of strain on the fibers, if the test piece had only been subjected to a direct load

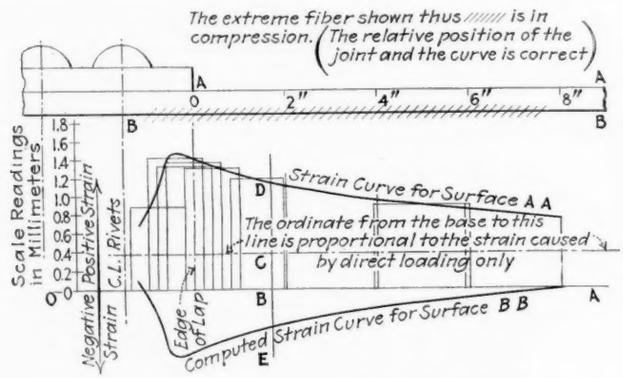

The extreme fiber shown thus //// is in compression. (The relative position of the joint and the curve is correct)
Scale Readings in Millimeters
Negative Strain
Positive Strain
C.L. Rivets
Edge of Lap
Strain Curve for Surface A A
The ordinate from the base to this line is proportional to the strain caused by direct loading only
Computed Strain Curve for Surface B B
The vertical sides of the rectangles drawn upon the base represent the difference between the scale readings obtained from the extensometer and fixed mirrors in their several positions. The vertical ordinates of the curve are proportional to the actual strain in the extreme fiber
POWER

FIG. 6. STRAIN CURVES FOR LAP JOINT

of three tons. The power curve indicating a compressive strain on the opposite side of the plate (*BB*) has been calculated from the values given on the upper curve by considering that the stress in both surfaces *AA* and *BB*, due to the bending action alone, must be equal and opposite. By combining the compression values with those calculated for a direct load of three tons the stress along the surface *BB* is found. This is accomplished by making the length of ordinates above and below the horizontal line, representing the strain for three tons, equal.

Significant and interesting is it that the indicated maximum strain in a lap joint, as shown by this test, was 3.9 times the amount produced by the direct pull and, therefore, agreed remarkably with the theoretical maximum value of four times the amount of this pull as determined by movements. The test piece with the joined ends of the plates already bent (see Fig. 2), was next tested similarly and the maximum fiber stresses along the surfaces were found to be materially reduced below those developed in the first specimen tested. These stresses were never double those produced by the direct load. The curve for strains in this test specimen is plotted in Fig. 7.

It will be seen in Fig. 7, that the strain curves vary only slightly from the line representing the effect of direct load at the point where the fractures usually occur. It is pointed out, that, while the stresses in the plate are materially reduced by thus forming the joint, the stresses on the rivets are evidently increased.

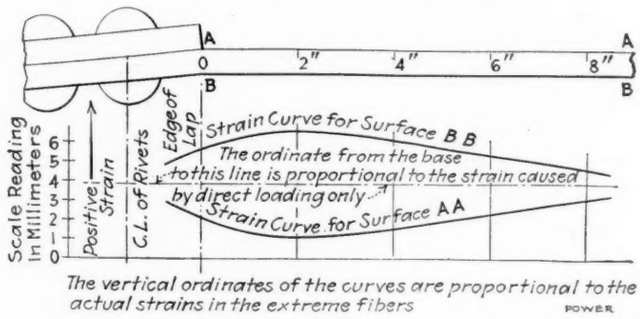

Scale Reading in Millimeters
Positive Strain
C.L. of Rivets
Edge of Lap
Strain Curve for Surface B B
The ordinate from the base to this line is proportional to the strain caused by direct loading only
Strain Curve for Surface A A
The vertical ordinates of the curves are proportional to the actual strains in the extreme fibers
POWER

FIG. 7. STRAIN CURVES FOR JOINT WITH FORMED ENDS

In using the fixed mirrors to eliminate errors caused by movement of the test piece as a whole, it was found that the amount of movement indicated by these mirrors depended upon the position which they occupied with respect to the riveted joint, and an investigation showed that the extensometer was not actually needed to measure the extension along the surface, for a series of fixed mirrors along the test line would indicate the relative amount the surface was bent at the various test points, and be a measure of the stresses produced by the bending action. To these indications could be added the calculated stresses due to direct loading which would give the total surface stress. This was known as the fixed-mirror method of testing.

A second series of tests was next undertaken, by the fixed-mirror method, which seemed to be particularly adapted for use on the shell of a boiler, because the fouling of the extensometer mirror on the shell was avoided. The load on the joints was produced by internal pressure, as it is actually. A Babcock & Wilcox drum, with a double-riveted lap seam, was used as one of the subjects for this test and the stresses were measured along a circumferential line crossing the joint and extending half way around the drum. These tests indicated that, for this joint, the maximum surface stress at the seam was, roughly, twice what would have been expected from direct loading such as would have been obtained if the drum had been a true cylinder without joints.

The drum was 36 in. in diameter and made up of three courses. The plate was ½ in. thick and the girth line, along which the observations were taken, was in the center course (an inner course) and 15 in. from the calking edge of the nearest girth seam. An interesting fact was developed by taking the observations over such a long line and which tended to confirm the accuracy of the observations. The solid plate of the center course opposite the line of joint on the end course exhibited under test a similar variation in the amount of stress as shown at the joints. Notwithstanding the distance of 15 in. between the end of the joint of the end course and the test point on the center course, the effect of this joint on the solid plate was to produce a maximum stress in the plate of, practically, one-half the amount shown at the tested joint. The location of the test line with respect to the joints is shown in Fig. 8.

Since the fixed-mirror method of testing did not take account of the total stress, but necessitated adding the calculated stress produced by direct loading, a third series of tests was made using a modified form of the Martens mirror extensometer.

On this form of extensometer, the fixed mirror was attached directly to the extensometer bar and the extensometer mirror was attached to its actuating prism by a link which brought it away from the surface of the plate. This arrangement eliminated any rotation of the fixed mirror due to disturbance of the surface of the test piece and also prevented the fouling of the extensometer mirror against the shell of the boiler. The bolted specimen, shown in Fig. 2, was tested with this modified form of extensometer and simultaneous readings were also taken during this test with fixed mirrors. The results were plotted for both plates and showed remarkable uniformity between those obtained by the two different methods of testing.

Testing riveted joints in this manner naturally suggested tests of other parts of boilers, such as dished heads. Tests of this kind indicated that the maximum stress on the inner surface of a bumped head is along the turn of the flange at the point where grooving is most likely to develop. The actual measurements in all cases during these tests were of stress and the assumption was made that the stress was proportional to the strain. Also, that the modulus of elasticity is taken at 29,000,000 lb. per sq.in. In boilers under pressure, the material is strained in two directions at right angles to each other and, under these conditions, the modulus of elasticity may change.

The authors' general conclusions are:

That in an ordinary straight-plate lap joint the maximum fiber stresses may amount to about four times the stress for which the joint is actually designed. In lap joints in boilers, owing probably to the stiffening effect of contiguous parts of the boiler, the extreme fiber stress may amount to about twice the stress for which the boiler is designed.

That "typical lap-joint failures," as the result of the extreme stress conditions present in this type of joint, are due to the want of symmetry in the design.

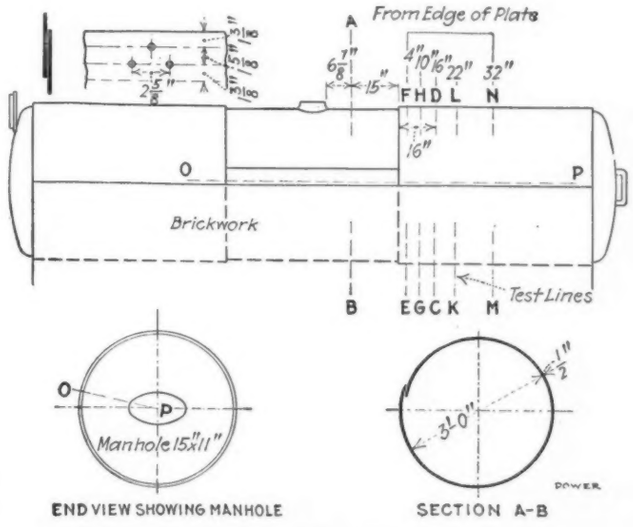


FIG. 8. BOILER DRUM (B. & W. TYPE)

That in the inspection of boilers particular attention should be paid to those parts where it is known that bending actions can occur and that these parts should be most carefully examined for incipient pitting and surface cracks.

That where pitting has been noticed, its progress should be very carefully watched and should it exist as a line of pit marks for any considerable distance, the examination should be most particular as the cracks run from one pit hole to another and the condition of the shell may be such as to be dangerous.

❋ ❋

Wages in the Amazon River Valley

BY HUBERT E. COLLINS

SYNOPSIS—Number of men employed, wages and methods of working in Brazilian power plants.

❋

Within the limits of the two principal cities of the Amazon River valley, Para and Manos, the same wages prevail. Within these boundaries, the rates given in the accompanying table apply. If the work is outside of these cities, then traveling, living and medical expenses are added. Many times an increased rate of wage is also asked in connection with outside work.

Within each of these two cities, there is an electric-light and railway plant, port works, water-works, gas works, rope works, sawmills and a brewery. All of these employ some one or more of the classes of help here enumerated, and the rates hold good in any of these industries. The men are all natives and give good service if properly trained. They like to excel and are anxious to learn any trade connected with engineering. They are good imitators but poor originators, so that the heads of departments are generally European. The accompanying photographs show some native power-house assistants in Para, Brazil.

In the table, native Portugese names of positions and the English equivalent are given, and the rates are also

given in Brazilian and American denominations. A reis is the smallest Brazilian currency. One thousand reis or one milreis is at the present time equal to $0.314 American money. The following comparative rates are figured at this ratio. The method of setting down the sums should be noticed. One milreis = 1$000. One

WAGE RATES IN THE AMAZON VALLEY CITIES

Positions	Hours per Day	Pay in Brazilian Money	Pay in American Money
Machinistas, engineers	12	425$000	$133 a month
Premeira ferrarlheiro, first assist. engineer	12	525$000	$165 a month
Electricistas, switchboard attendants, electricians	12	10$000	$3.14 a day
Foginistas, firemen	8	7$500	$2.36 a day
Lubrificadores, cleaners	12	4$000	$1.26 a day
Comedor d'agua, water tenders	8	8$000	$2.51 a day
Carvoliros, coal passers	8	160$000	$50 a month
Premeira classe ferralheiros, machinists first-class	10	425$000	$133 a month
Segund classe, second-class	10	400 to 1$000	13 to 31c. an hour
Helpers		200 reis	6c. an hour
Carpenteiros, carpenters	10	700 to 800 reis	22 to 25c. an hour
Pedreios, masons	10	400 to 800 reis	13 to 25c. an hour
Ferreios, blacksmiths	10	400 to 800 reis	13 to 25c. an hour
Internos, helpers	10	200 to 600 reis	6 to 19c. an hour
Premeira interno, foreman	10	160$000	$50 a month
Vigias, watchmen	12	160$000	$50 a month
Apontador, time-keeper	12	200$000	$63 a month
Electricistas, lamp trimmers, wiremen, repair men	12	400 to 700 reis	13 to 22c. an hour

hundred milreis = 100$000. The dollar sign ($) is always placed at the left of three figures.

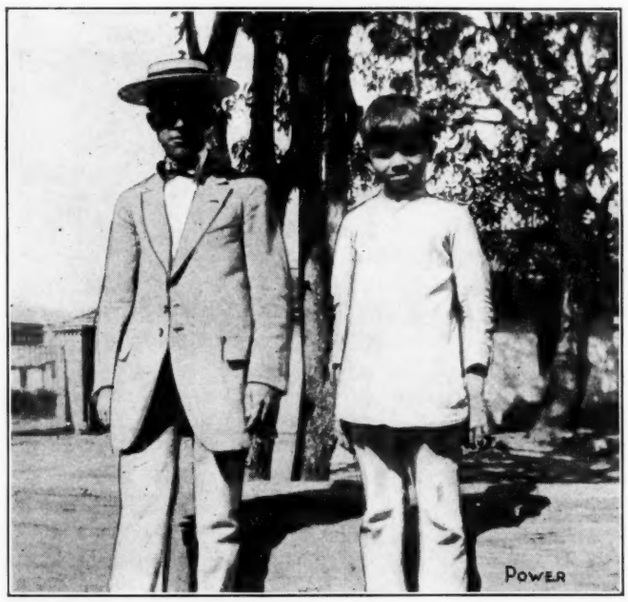
Since the United States' demonstration of the efficacy of sanitation at Panama, all the cities in the tropics have copied the same methods. The result is that European people or Americans can live here if they take reasonable care of themselves. It may interest some to know the salaries paid to heads of departments. The salary generally includes transportation to and from quarters, medi-

GROUP OF FIREMEN IN PARA, BRAZIL

cal attendance, vacation with pay, and table board. In some instances the table board is not included. In this event, the men club together and live in staff houses.

General Manager of Railway & Lighting Co.	$9,000 a year
Chief Engineer	6,000 a year
Master Mechanic	6,000 a year
Superintendent of Transportation	4,800 a year
Superintendent of Lines	4,800 a year

On the Amazon River there is an ever increasing traffic employing marine engineers and pilots, all of the latter being natives. Most of the chief engineers are licensed by the government. Engineers are graded first, second and third class. Applicants must go to Rio de Janeiro to be examined for a first-class license; to Para for a second-class license; and to Manos for a third-class license. A fee of 200, 150 and 100 milreis, respectively, is charged the applicant. The pay of these men ranges from 400 to 600 milreis per month and living expenses. The pilots receive 600 milreis per month



BRAZILIAN TIMEKEEPER AND CABOCCA HELPER

on duty and 300 milreis while on shore, awaiting orders.

The writer believes, that with proper instruction and discipline, the same amount of labor can be obtained from the natives in Brazil as from men foreign to the country. It must be borne in mind that tropical conditions exist in the two cities mentioned. The Amazon River from its mouth to Manos, a distance of over 1100 miles, is within four or five degrees of the equator. In either one of the cities the temperature every day in the year is never less than 86 deg. F. at night, and, of course, the heat is more intense during the day. For this reason it is not expected that any class of help can do as great an amount of work as in a temperate zone.

Some idea of the amount of labor required may be obtained by an analysis of the working force of a 3000-kw. power plant in one of these cities. The number of men employed in this plant is 110, consisting of one chief engineer, one first assistant engineer, four assistant engineers, five switchboard attendants, seven oilers, eight cleaners, two water tenders, seventeen firemen, four coal passers, three blacksmiths, fifteen machinists and repairmen, two masons, three carpenters and thirty-eight helpers.

By referring to the wage list, it may be noticed that the firemen, water tenders and coal passers work in eight-hour shifts. The peak load always comes during the hours of the afternoon and evening watch, 4 to 12 o'clock. At that time one fireman is stationed at each boiler in service, and for about four hours of his watch handles over a ton of coal an hour. The firemen are shifted every week so as to give each a turn at the lighter work of their

department. At the time the observation was made, the total coal consumption of this plant averaged 40 long tons a day of 24 hours, so that the average amount of coal handled by the firemen is 0.23 long ton per man. The coal is run in on a trestle and dumped in front of the boilers. The coal passers move from one fire to another and shovel the coal close up in front of the boilers so that the firemen always have their coal within reach when charging a boiler. The boilers are also attended by water tenders so that the firemen do not need to perform this duty. During the afternoon watch the firemen are compelled to work their forces almost incessantly. They are in a dripping perspiration within five minutes after they come on duty, and they are in that condition until they stop working. When fires are cleaned, the coal passers clean out the ashpits and haul away the ashes.

In this plant the chief engineer takes charge during the day, and the first assistant engineer is required to take charge of the boiler and engine room during the night. There are two assistant engineers on the floor at all times, and it is their duty simply to start and stop engines. There are four oilers on duty during the night, and three during the day. They attend to the engines and condensing machinery.

There are eight cleaners who work in 12-hour shifts, and it is their duty to mop floors, wipe engines and generators and keep the switchboards clean. The switchboard attendants are in the gallery at all times and have nothing to do with the generators. In addition to these men, there are blacksmiths, machinists, repairmen, masons, carpenters and helpers, all of whom work during the day.

It was found upon observation and careful study, that this total working force could be greatly reduced. By a gradual process of rearrangement, the number of oilers was cut down to three; the number of helpers was reduced to ten; one blacksmith and two machinists and repairmen were retained. The masons and carpenters were disposed of entirely.

Among the machinists and repairmen there are men who were trained to keep the boilers clean, and to repair the brickwork wherever it was necessary. At least one boiler was taken down each day to have the tubes swept and for any necessary repairs to the brickwork or baffles. Among the helpers there are men who also operate the coal cars, running the coal in from the bunkers to the boiler room.

In handling these men, a great deal depends on the man in charge. If he will exercise due patience, and will be explicit in his instruction so that the men understand everything he tells them, they appreciate it and try to do their best. To be connected in any way with engineering is always considered a great honor among these people.

Most of these men are steady workers, some of them having worked from ten to twelve years in the one place, and over half of them for at least two years. Among those who come and go there are quite a number who are trained in some department of power-plant operation, so that it is possible to pick up men in each of these cities who are trained workers.

Recent Developments in Turbine Reverse Buckets

By O. D. H. Bentley*

SYNOPSIS—In turbines of the Riedler-Stumpf type the presence of the nozzle causes the steam to be redirected upon the wheel not at the edge but somewhat toward the center of the receiving bucket. The article describes a nozzle block designed to overcome this defect.

In a single pressure, multiple velocity-stage turbine, such as described herewith, there is no question but that the nozzle and reversing chambers contribute more to the performance or efficiency of the turbine than any other parts. In other words, the initial nozzle and reversing chambers are the vital parts of the turbine, as far as practical results are concerned, and because this fact has been realized by the majority of steam-turbine designers, a great deal of thought has been concentrated on these details of the turbine.

It is surprising to note the variable results that can be obtained by slight changes in these nozzles and reversing chambers. For instance, Fig. 1 shows a photograph of a nozzle which has been used with considerable success, the water rate of this nozzle plotted against speed being shown by curve *a*, Fig. 3. Likewise, the results obtained by the nozzle and reversing chambers, shown in Fig. 2, are plotted in curve *b*, of the same figure. The difference in results is probably wholly attributable to the reversing chambers, and to the reversing chambers forward of the rear supplementary reversing chamber, for this latter and the initial nozzles are identical in each case.

A positive explanation of this difference would be difficult to make, but the writer believes that it is caused by the inefficiency of the small reversing chamber, shown in Fig. 1 alongside of the initial nozzle. That is to say, the steam coming from this small reversing chamber is directed into the bucket wheel, as illustrated in Fig. 4, and instead of being delivered at the side of the bucket, as it should, it is discharged into the center, as shown, and must necessarily mingle with, and interfere more or less with the nozzle steam. It is a well known fact that the best results cannot be secured if two streams at different speeds are allowed to mix, for they cause eddies which reduce the velocity.

Fig. 5 shows the corresponding reversing chambers for nozzle No. 2. There is, in this construction, no reversing chamber which corresponds to the smaller reversing chamber which is alongside the nozzle in Fig. 1. The first reversing chamber which, as shown in Fig. 5, is just forward of the nozzle, delivers its steam at the outside of the wheel bucket, while, in addition, the steam films are better separated, and it seems reasonable to assume that this is the principal reason why the nozzle illustrated in Fig. 2 gives the higher efficiency.

By referring to the characteristic curve *a*, in Fig. 3, compared with curve *b*, it will be seen that the efficiency of nozzle 1 increases the faster as the speed is increased,

*Manager of the Turbine Department, B. F. Sturtevant Co.

which would bear out the above reasoning that the small bucket alongside of the initial nozzle in segment No. 1 is less detrimental as the speed is increased. In other words, the speed of the wheel carries the steam further forward in the direction of rotation. Consequently, a smaller percentage of the steam is delivered into this small reversing chamber as the speed increases.

It has been found by experiment that the best efficiency can be obtained when the initial steam jet entering the wheel of this type does not exceed 20 per cent. of the width of the wheel. This point is illustrated in Figs. 6 and 7. No doubt, the smaller the ratio of the steam jet to the width of the wheel, the greater the efficiency, that is, as far as the nozzle and bucket are concerned. Of course, if this width is reduced to an unreasonable degree the rotation losses of the wheel become a larger percentage of the output, and more than offset the increase in efficiency of the nozzle. Therefore, there must be a ratio that will give the best output result, and this has been found to be between 15 and 20 per cent. of the width of the wheel. Of course, as the steam enters and reënters the wheel the steam film is becoming wider because of the fact that its speed is being reduced, but the subsequent impacts in the rotor become less and less effective, and this increase in width is not so detrimental as in the initial jet, as the energy extracted varies as the square of the steam velocity.

It has been found that the steam passes through the rotor in a design of this kind, practically three times. Roughly speaking, the steam gives up 75 per cent. of its energy the first impact, 20 per cent. the second and 5 per cent. the last. This ratio, of course, varies with the rim velocity of the rotor and the initial and terminal steam conditions. While there are four reversing chambers shown in Fig. 2, it does not necessarily hold true that the steam makes four complete reversals, but it has been found by experiment that four chambers, as shown in this design, give the best efficiency under the usual operating conditions. The dotted curve, designated as *c* in Fig. 3, shows the relative effect of nozzle No. 2 with the last of the reversing chambers removed. In other words, this has three diagonal reversing chambers forward of the supplementary chamber and the initial nozzle.

One would naturally think that the higher the rim velocity of the rotor, the fewer the number of reversing chambers which would be required, because the first reversal would extract a larger percentage of the energy, leaving a small amount to be taken out in the subsequent reversals. While this is true as far as the amount of energy taken out in each reversal is concerned, it does not hold that three reversing chambers will show better efficiency than four at high speeds, as can be seen from

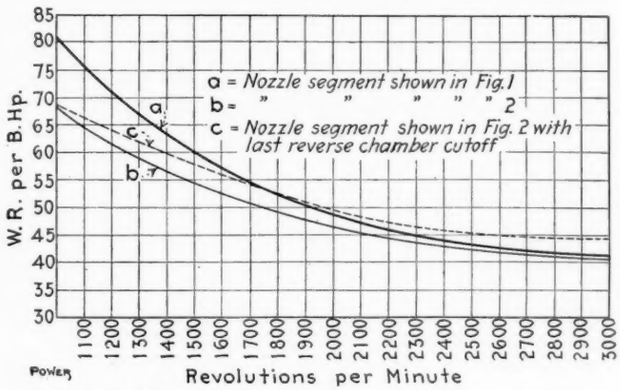


FIG. 3. RELATION OF WATER-RATE AND SPEED

curve *c* above referred to. The explanation of this is probably the fact that at high speed the rotor advances the steam so rapidly that more work is done in the forward chambers than would be at relatively slower rotor speeds.

Another point in favor of nozzle No. 2 is shown in Fig. 8. This shows, in full lines, a development of the rotor, with a development of the initial nozzle and reversing chambers in dotted lines superimposed. It will be seen that it is impossible for any relation to exist between the reversing chambers and rotor whereby there will be no free, unrestricted path available when the steam is traversing the rotor and reversing chamber buckets. In other words, if the rotor were held in a stationary position in any relation whatever to the nozzle, the steam would find an easy exit. This would not be the case with nozzle No. 1, providing the relation existed where the buckets in the rotor exactly coincided with the initial nozzle and the small bucket at its side. That is to say, in nozzle No. 1, at a certain instantaneous relation between stator and rotor, the exit is temporarily closed.

From a manufacturing standpoint, it would at first

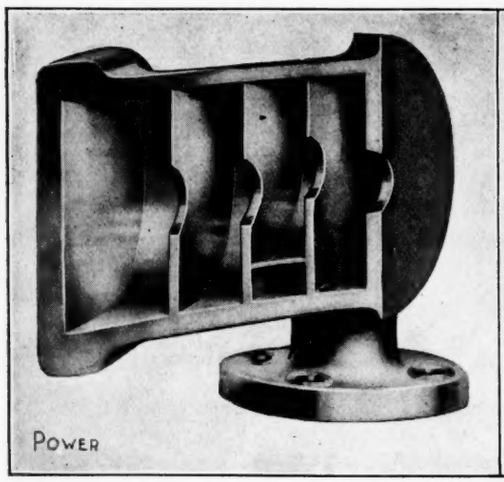


FIG. 1. THE OLD

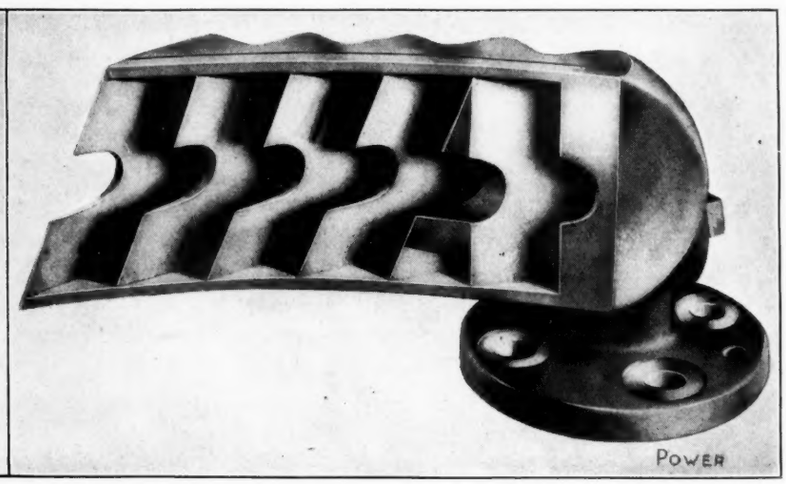


FIG. 2. THE NEW

STURTEVANT TURBINE NOZZLE BLOCKS

appear that nozzle No. 2 would be much more difficult to produce, but a method has been worked out whereby these reversing chambers are machined with a very slight excess in cost over nozzle No. 1. Each reversing chamber is made by two cuts, approximately one-half the width of the bucket, and it is necessary only to square up the corners at the receiving and discharge ends of these chambers.

While at present it is possible to get a slightly higher

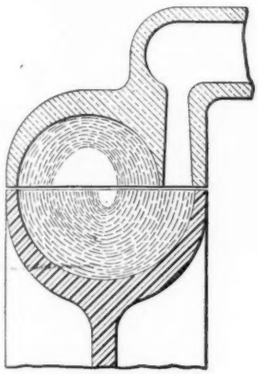


FIG. 4

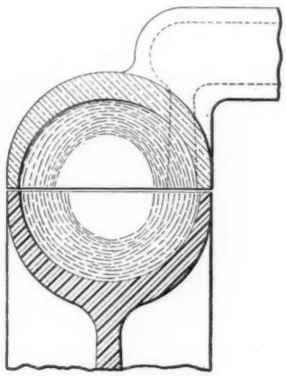


FIG. 5

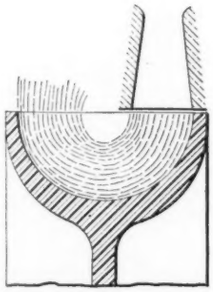


FIG. 6

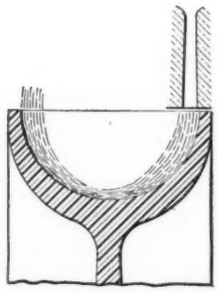


FIG. 7

efficiency with a properly designed multi-stage turbine, it is believed that there are even greater possibilities with a single-stage turbine, than those already achieved. If the economy of a single-stage turbine can closely approximate that of a multi-stage machine, the single-stage turbine will have a decided advantage, not only because of its initial cost, but especially because of its simplicity,

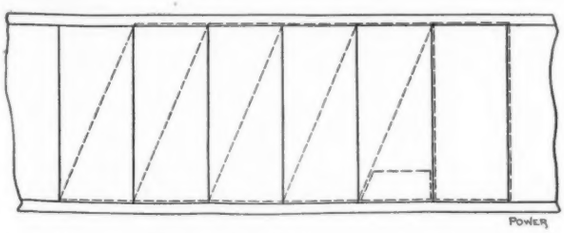


FIG. 8. DEVELOPMENT OF BUCKETS AND SUPERIMPOSED NOZZLE BLOCK

light weight and reduced size. The single-stage turbine is more likely to maintain its original efficiency as there is no tendency for leakage between the stages, while the efficiency of the multi-stage turbine is bound to decrease, due to the increasing leakage around the shaft at the diaphragms. The multi-stage argument that the steam velocity is lower, and the rotor buckets are not so severely subjected to the action of the steam, is true, no doubt, but when constructed of proper material, and using reasonably dry steam, the efficiency of a single-stage turbine can be maintained practically indefinitely.

Future development in the single-stage turbine will probably be confined to the reversing buckets rather than the initial nozzle or rotor, and it is believed that there is greater opportunity for increasing the efficiency of the single-stage than the multi-stage turbine; in other words, the multi-stage has been more perfectly developed to date. Even in its present state of development, however, the single-stage turbine, in small powers, is better adapted for noncondensing work.

Fusible Signal Plugs for Air-Compressor Machinery

The Hodges fusible signal plug which is being placed on the market by the Ingersoll-Rand Co., 11 Broadway, New York City, is devised to give warning of a rise in temperature to a point which has been previously determined upon as the limit of safety. Thus it may guard against the development of excessive strains or other dangerous conditions.

This device consists of a body formed for screwing into a hole tapped for a ¼-in. pipe thread in the wall of the apparatus to be protected, an ornamental cap and a removable stem containing the safety element. The device is neat in appearance and as there are no movable parts, no attention is required by the operating engineer. The material used is mostly brass and copper, and is unaffected by atmospheric conditions.

The plug can be placed in the discharge space of a single-stage compressor, in the high-pressure side of a two-stage compressor, in a receiver or other air container, where, if an excessive rise of temperature occurs, the safety element melts and opens a minute passage through the stem to the head, allowing a small amount of air to pass, producing a distinctive whistle that cannot be overlooked by anyone in the vicinity. This will continue until measures are taken to reduce the primary cause of the threatened trouble. It is then but a moment's work to replace the plug with a new one and the machine is again protected against a similar recurring danger.

These signal plugs are supplied in two types with 350- and 500-deg. F. blowing points, respectively. The 350-deg. plug is suitable for use in the discharge pipe of a single-stage compressor working at 40 lb. gage pressure; in the discharge side of a two-stage compressor working at 100 lb., or in the discharge side of a three- or four-stage compressor, delivering air at 100 lb. The 500-deg. plug is for use in the discharge pipe of a single-stage compressor working at 100 lb. pressure.

Safety on the oil-burning vessels in the Navy will be increased by the provision, on such ships, of an oxygen breathing apparatus. It is estimated that about 10 lives are lost each year on these oil-burning vessels, when men are overcome by gases escaping from the liquid fuel. The apparatus is simple, consisting merely of a small oxygen tank, a flexible tube, and a mouth piece covering the nose and mouth, but not hindering the vision as the usual helmet does.—"Engineering News."

The average monthly salaries for engineers in the Swedish merchant marine, states "International Marine Engineering," are: Chief engineer, $81; second engineer, $58; third engineer, $48; fourth engineer, $27, and fireman $17.

ELECTRICAL DEPARTMENT

Dynamo and Motor Troubles

By R. L. Mossman

The following article explains some of the troubles in the operation of dynamos and motors, giving the causes, symptoms and remedies. It is well in all cases to make a careful examination and not jump at conclusions.

Heating of Bearings

1. Excessive belt tension in which the pulley bearing will probably be hotter than the other. To overcome this, reduce the load or belt tension.

2. Failure of oil rings to revolve with the shaft; oil too low; poor grade of oil; grit in the bearing or a bent shaft. The remedy is obvious.

3. End thrust due to improper leveling or no lateral motion of the shaft—if a belt-driven machine, move the shaft back and forth with a stick pressed against the end of the shaft. The shaft should have a lateral movement of about ⅛ in. and should float when running. If it does not, it is probably held in one position by the belt, the pulley or the collar. Sometimes the armature projects out more on one side of the field coils than on the other; in this case, the magnetic pull of the field coils will draw the armature in and the pulley or collar may bind against the bearing and cause heating.

4. Unequal air gap—See that the air gap is equal all around the armature, for, if it is nearer one pole-piece than another, the magnetic pull will be unequal.

Heating of Field Magnets

1. Moisture in the coils—This will be indicated by the field circuit testing lower in resistance than normal in that type of machine. In shunt-wound machines, the field would take more current than ordinary. The insulation resistance will also test low. To remedy this condition, the coils should be baked in an oven for several hours, or current may be passed through them; or both means may be used.

2. Excessive current in the field circuit—The symptoms are, the field coils will become too hot to permit holding the hand on them. Their temperature will be over 50 deg. C. above the surrounding air. In the case of a shunt-wound, or separately excited machine, the voltage should be decreased at the terminals of the field coils or the resistance of the coils can be increased by adding more wire or by putting resistance in series. A short-circuit could also cause heating; this would be indicated by the short-circuited coil being cooler than the others.

Heating of Armature

1. Excessive heating in armature coils—In this case reduce the load.

2. Short-circuited armature coils, caused by moisture or defective insulation—Test the coils, and remove the cause; if this be moisture, then dry out as for the field coils.

3. One or more reversed coils in one part of the armature—Test for this with a compass and, if found, reconnect the coil to agree with the others.

4. Heat conveyed from other parts, such as the commutator or bearings—In this event, start the machine cool and notice which parts heat up first.

Heating of Commutator and Brushes

1. Heat spread from other parts of the machine.

2. Sparking—Any of the causes of sparking will cause heating more or less.

3. An overheated commutator will decompose carbon brushes and cover the commutator with a film of carbon, which offers resistance and increases the heat. The commutator and brushes should be cleaned and the brushes fitted to make good contact at the proper points.

4. Bad connections in the brush-holder—For these, test out the connections by the "drop" method for higher resistance than normal and improve the connections.

5. Arcing or short-circuiting between the segments—The symptoms are a burned spot at the point of short-circuit. If this is noticed, pick out the charred particles and repair the commutator.

6. Carbon brushes heated by current—To remedy this, see that the brushes fit the commutator and are properly spaced. Use larger brushes so that the current density does not exceed 30 or 40 amp. per sq.in. of contact area, or use lower resistance brushes

Sparking at Commutator

Sparking is not very objectionable if moderate in amount and duration. Beyond this, however, it is likely to burn and roughen the commutator and cause heating.

1. It is sometimes caused by the armature carrying too much current, due to overload or excessive voltage. If excessive current flows for any length of time, the whole armature becomes heated. An overload, due to friction, may be detected by turning the machine by hand. A convenient and sensitive test for any size of machine is to determine the current required to run the armature free (operating as a motor) which should not be more than 4 or 5 per cent. of the current at the rated load, except in machines of 10 hp. or less, which may take 6 to 10 per cent. The remedy in this case is to reduce the load, reduce the speed of the machine, or decrease the field strength in the case of a dynamo and increase it in a motor.

2. Sparking may also be caused by the brushes not being set at the neutral points. In this case the brushes should be shifted backward and forward until sparking is reduced or eliminated. If the brushes are not set opposite each other, or in a four-pole machine 90 deg. apart, they will spark. To set them, count the commutator segments, or wrap a piece of paper around the commutator and divide it into the same number of equal

parts as there are sets of brushes. Then, set the brushes to the marks on the paper, which will space them equally. The usual position of the brushes is nearly opposite the spaces between the polepieces; but, on some machines, this will not hold good, and it is necessary to give a forward lead (in the direction of rotation) to the brushes in the case of a dynamo and a backward lead in the case of a motor.

3. A commutator may have high bars, flat bars, projecting mica or be rough. If such proves to be the case, the commutator may be made smooth with a fine file or sandpaper. If it is very rough or eccentric, it should be turned off. For turning use a diamond-pointed tool with a very sharp and smooth edge. Take a very fine cut each time to prevent tearing or catching in the copper, which is very tough, and finish with a fine file and sandpaper. Any particles of copper should be carefully removed from between the bars. Use a little oil or vaseline on the commutator, if necessary.

4. The brushes may make poor contact, in which case they should be fitted to the commutator by drawing a piece of sandpaper between them and the latter. See that the brush-holders work freely and that the brushes do not bind in the holders.

5. A short-circuited or reversed coil in the armature may cause sparking. This will cause a motor to draw excessive current even when running free without load,

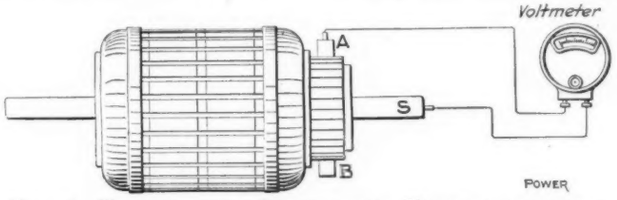


FIG. 1. TESTING FOR INSULATION RESISTANCE WITH VOLTMETER

or a generator will require considerable power even without any external load. A reversed field coil can be located with a compass; the coils should be alternately north and south or should alternately attract and repel one end of the compass needle. If a coil proves to be short-circuited, it will burn out under load and should be removed. A reversed coil may be connected properly.

6. An open circuit in the armature will also cause sparking. It is usually indicated by long, heavy flashing, and the commutator bar, or mica, nearest the break is usually badly burned or eaten away. These symptoms might be laid to high bars; but an open circuit can be distinguished by slowly turning the armature when violent flashing will continue. After the break has been located, if a permanent repair cannot be made at once, the sparking can be stopped by connecting together with solder the two bars adjacent to the break; this will cut out the defective coil; but the coil should be repaired permanently as soon as possible.

7. Still another cause of sparking is a grounded armature. Two or more grounds would have practically the same effect as a short-circuit and should be treated the same. A single ground would have little or no effect, provided the circuit is not grounded at some other point. On an electric railway, or other circuit with an earth return or a three-wire system with the neutral grounded, one or more grounds in the armature would allow the current to pass directly through them and would cause the machine to spark. A ground will sometimes be produced by the static electricity from the belt puncturing the insulation, if the frame of the machine is insulated from the ground. If the frame is grounded, this cannot happen. The frame of a machine that is insulated can be grounded through a high resistance, which will carry off the static charge. The remedy for a ground is obvious.

8. A weak magnetic field will be indicated by the polepieces not being strongly magnetic when tested with a piece of iron. The position of least sparking is shifted considerably from normal, due to the relatively strong distorting effect of armature reaction. In a shunt-wound motor, under these conditions, the speed is unusually high; whereas a generator fails to provide full voltage. A reversed field coil will weaken the field magnetism and cause sparking. If the series coil of a compound-wound machine opposes the shunt coil, it will reduce the voltage instead of raising it when the load increases.

FAILURE TO GENERATE

This is usually due to the inability of a self-exciting dynamo to "build up" its field magnetism. The proper starting of such a machine requires a certain amount of residual magnetism, which must be increased to full strength by the current generated by the machine itself.

1. The residual magnetism may be too weak or destroyed, due to vibration or jar, proximity of another machine or a reversed current through the shunt or series field coils, but not enough to completely reverse the magnetism. If it is completely reversed, the machine will build up a field of opposite polarity. The symptoms are, little or no attraction when the polepieces are tested with a piece of iron. The trouble may be remedied by sending a magnetizing current through the field coils from another machine or battery; if this fails, apply the current in the opposite direction, also the brushes may be shifted backward to make the armature magnetism assist that of the field.

2. Reversed connections of half of the field so that one-half opposes the other will make the generator fail to generate. This may be detected by testing with a compass.

3. Short-circuit in machines: If the short-circuit is in the external circuit, it will prevent the building up of a shunt-wound machine, but will assist a series-wound machine.

4. An open circuit may cause failure to generate, which may be due to a broken wire or faulty connection in the machine, or to poor brush contact.

TESTING AND LOCATING FAULTS

Locating a reversed coil in the armature—Supply a moderate current to each coil in succession by touching the wire to each two adjacent commutator bars and hold a compass over the corresponding coil. The latter will reverse when the reversed coil is reached.

Testing insulation resistance with a voltmeter—This test is made with the machine running. Connect the voltmeter across the brushes A and B (Fig. 1) and note the reading; call this E. Then connect the voltmeter as shown and call this reading E_1. Let R equal the resistance of the voltmeter and X the insulation resistance. Then

$$\frac{E \times R}{E_1} - R = X$$

To test the field coils for a short- or open circuit, connect to the source of current, as in Fig. 2, using lamps to regulate the current. Connect the voltmeter across the coils, as at *AB, CD, EF* and *GH*. If the voltmeter readings are the same for all coils, the coils are all right, unless they should all be short-circuited, which would be unlikely. If any coil is short-circuited, the reading of the voltmeter will be low. If the coil is open, the voltmeter will show a higher reading. The actual resistance of each coil can be found by connecting an ammeter in

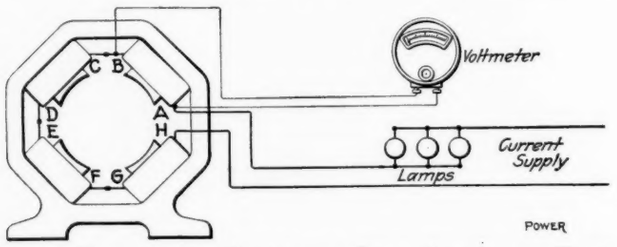


FIG. 2. TESTING FOR SHORT- OR OPEN-CIRCUIT IN FIELD

the circuit. By Ohm's law, the resistance will equal the electromotive force, divided by the current, or $R = E \div I$.

A ground can be located with a magneto or by using a voltmeter or lamps. Fig. 3 shows connections for testing armature coils, for open, partly open or short-circuited coils. Here *A* is a low-reading ammeter, which is adjusted by means of a shunt to give a large deflection when the leads *D* and *E* are short-circuited. The leads are then brought in contact with adjacent segments of the commutator; the deflections being compared with one another to give the comparisons of the resistance. If a coil is open, or the connections broken, the ammeter will give a low reading when spanning its segments. If a coil is partly open, the high resistance

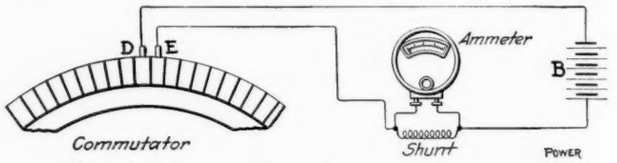


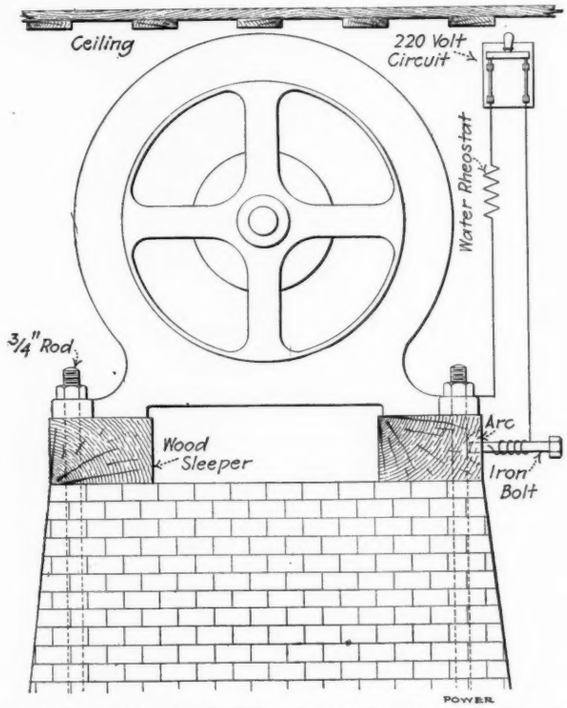
FIG. 3. TESTING ARMATURE FOR SHORT- OR OPEN-CIRCUIT

at fault will give a low reading on the ammeter. A short-circuited coil will show a greater deflection than a good coil.

The temperature rise of the armature and field coils can be measured with a thermometer laid on the part and covered with cotton waste; but such tests do not show the heat within the coil. A better method is to take advantage of the rise of resistance due to the temperature rise. The increase is about 0.004 ohm per deg. C. for each ohm of resistance of the coil.

Removing Foundation Bolts

Some time ago we wished to move one of our motors which was anchored to the brickwork by ¾-in. rods as represented in the sketch. There was not room enough to remove the nuts and lift off the motor, because of the ceiling overhead, which had been constructed after the motor was in place. We, therefore, connected one side of a 220-volt circuit through a water rheostat by means of a wire clamped under the nut as shown. A hole was made in the wood sleeper to reach the rod and through this hole contact was made to the rod from the other terminal of the circuit by means of a wire to the end of which a short iron bolt was attached. The arc was struck



SHOWING HOW FOUNDATION BOLTS WERE REMOVED

by breaking the contact. The current was maintained at about 30 amp. for three minutes, when the rod became red hot at that point; then by tightening on the nut and striking the rod a few blows it was severed. This was repeated for each rod, and the motor moved horizontally.

Washington, D. C. CHARLES W. MORTIMER.

Static Charges on Belts

In reference to an inquiry signed J. H. G. on "Avoiding Static Electric Shocks" with your answer to same published in the Mar. 25 issue, I would point out that the grounding of hangers, bearings, etc., is not sufficient to remove all the static electricity from a moving belt. A rather careful investigation of this subject was made by the E. I. duPont deNemours Powder Co. some time ago and it was found that in addition to such grounding, it was advisable, where desirable to remove all the accumulated static charge, to install metal combs on the underside of the belt close to the point where it left the revolving pulleys, and in addition to this to treat the outside surface of the belt periodically with a half-and-half mixture of glycerin and water. The generation of such static electricity seems to be brought about by some internal movement of the particles or fibers of the belt structure, and the static charge appears equally strong along the entire length of the belt and is little affected by increased tension or slipping of the belt.

Since the belt material is usually a nonconductor of electricity, in order to dissipate the charge it is necessary to render it conducting. This is achieved by the use of glycerin and water.

Wilmington, Del. L. A. DEBLOIS.

GAS POWER DEPARTMENT

Some Developments of the Gas Engine

By Everard Brown

The first practicable four-stroke-cycle gas engine was invented about 50 years ago by Otto in Germany. For a long time its manufacture was restricted to small sizes, largely because of the necessity of cooling the exhaust valve which, it was thought, would entail many undesirable complications. To eliminate this, the two-stroke-cycle engine was developed as, in this, the piston acts as an exhaust valve by uncovering ports through which the waste gases escape.

Two-Stroke-Cycle Engines

One of the earliest commercial two-stroke-cycle engines was invented by Dugal Clerk, of London. It had a simple cylinder, was single acting and had a common air and gas pump, independent of the power cylinder. This pump scavenged and charged the cylinder through a main inlet valve when the power piston was at the end of its stroke and the exhaust ports were uncovered. No attempt was made to build this engine in larger sizes, although a number of the small sizes were put into use. Its manufacture was finally abandoned, because it was found to be more expensive to build than the Otto four-stroke-cycle engine.

About this time Oechelhäuser, of Berlin, invented a two-stroke-cycle gas engine that came into considerable prominence. This engine consisted of a cylinder with both ends open and had two pistons, each of which worked at one end of the cylinder in opposite directions and were connected to what might be called a common three-throw crankshaft. One piston uncovered a row of inlet ports through which the gas and air were admitted while the other simultaneously uncovered a row of exhaust ports through which the waste gases escaped. During the interval that the pistons were in these extreme positions the cylinder was scavenged of the waste gases and charged with fresh air and gas by independent pumps. Then as the pistons approached each other the charge was compressed at the middle of the cylinder and then ignited. This engine had the distinct advantage in that there were no valves exposed to high temperatures and pressures, for one piston acted as the inlet valve while the other acted as the exhaust valve. The development of this type was a long step forward as it eliminated all the valve-gear troubles heretofore incident to gas-engine operation. It was not long, therefore, before larger units were built; in fact, many of the leading manufacturers abroad are still building this type, with slight modifications,* in sizes ranging from 500 to 1500 hp. for operating rolling mills, electric generators and blowing engines.

This type has certain disadvantages, however. For example, the power required by the independent scavenging and charging pump ranges from 8 to 10 per cent. of the total power developed. Furthermore, as it is essentially a single-acting engine, it produces but one impulse per revolution, which necessitates a large flywheel and also makes the cost per horsepower high. Another disadvantage is that the power must be taken off at the three-throw crankshaft in order to balance the stresses. In fact, the shaft has been known to fail in some instances where the forces have not been properly balanced because of attaching the blowing-engine cylinder direct to one of the pistons. To offset this disadvantage, however, this engine has no valve-gear with its attending complications.

The next two-stroke-cycle engine of prominence was that invented by Koerting. There is a good example of this type on a large scale at the Lackawanna Steel Co.'s plant in Buffalo. As originally brought out, this engine was single acting and was similar to that invented by Clerk, the principal material difference being that the air and gas pumps were separate, thus giving better control of the mixture. Also, the Koerting engine had an ingenious system of piping between the pumps and the main inlet port of the cylinder, admitting a quantity of air in advance of the mixture to scavenge the waste gas. By this arrangement the mixture could also be stratified for reduced loads.

Later, this engine was made double acting, the power cylinder having a row of exhaust ports in the center that are exposed by the piston when it is at either end of the stroke. At each end of the cylinder there is a main inlet valve through which the charge is admitted simultaneously with the exposure of the center exhaust ports by the piston.

Among the criticisms that may be advanced against the Koerting engine is the location of the valves in the head. In order to examine or remove the piston it is necessary to break the air and gas connections and remove the valve-gear. Another objection is that the power consumption of the air and gas pumps is said to be from 10 to 15 per cent. of the total power generated by the engine. Furthermore, the interval of time when the piston is at the end of its stroke, during which the cylinder must be scavenged and charged, is very short; therefore, the main inlet valve must be large and must operate through a considerable distance in order to admit sufficient mixture in the short interval allowed. As compared with a four-stroke-cycle engine the valve must open and close in one-quarter the time. In addition to this it must travel through a greater distance. Some of these objections have now been overcome to a certain extent. However, a feature to commend this type is the absence of exhaust valves as compared with the double-acting, four-stroke-cycle engine. Whether the troubles incident to such valves are sufficiently serious to offset the objections mentioned as relating to the two-cycle engine is a question for debate.

Four-Stroke-Cycle Engines

During this development of the two-stroke-cycle type, the four-stroke-cycle principle was by no means aban-

*The Junkers engine.

doned. On the contrary, it received probably as much attention from some of the leading European builders as did its competitor, consequently the development of both types progressed simultaneously. The manufacturers largely responsible for the development of the four-stroke-cycle engine are: The Otto Gas Engine Co., of Cologne, the John Cockerill Co., of Liége, the Nürnberg Engine Co., of Nürnberg, and the Premier Engine Co., of Nottingham, Eng. Germany, however, deserves more credit for the advancement of the gas engine than all the other countries combined.

Until a few years ago the four-stroke-cycle engine was built as a single-cylinder, single-acting unit in which the piston was exposed to air circulation and, therefore, did not require water cooling. Probably one reason for this was the belief that cooling the piston by means of circulating water would materially reduce the engine efficiency. Also, it was thought impracticable to build a stuffing-box for the piston rod that would withstand the heat. A little later the design was changed to a tandem two-cylinder construction but still single acting. Subsequent investigations proved that water cooling of the piston did not materially affect the economy and as a result the double-acting, tandem two-cylinder construction was made possible. The development of metal rings for packing the piston-rod stuffing-box also hastened the adoption of this newer type. Both of these developments gave a great impetus to the four-stroke-cycle engine as it practically put it on the same basis with the Koerting two-cycle engine as regards regulation and cost per horsepower with the advantage of having greater mechanical efficiency. This form of construction was developed only about 15 years ago.

At first almost all of the leading manufacturers located the valves in the heads of the engine cylinder which, obviously, was an objectionable feature. The next important step, therefore, was the placing of these valves in the cylinder body. This left the heads free for removal when necessary for the examination of the piston and the interior of the cylinder. This form of construction—tandem, two-cylinder, double-acting and four-stroke-cycle, with the valves located on the cylinder body—has now been so generally adopted that it is looked upon largely as the standard practice. Subsequent improvements have been of minor importance relating mostly to details of regulation, valve-gear and cylinder construction.

As the higher thermal efficiency of the gas engine over the steam engine has been well known for the past 30 years, at least, it is surprising that the latter has not been supplanted. The apparent hesitancy to do this can, no doubt, be largely attributed to the various mechanical difficulties encountered in the development of the modern gas engine which had to be surmounted step by step. Furthermore, the delay in taking it up more generally in the past was also due to the lack of a satisfactory gas producer to supply the fuel. For a long time blast-furnace gas, because of its low thermal value, was considered wholly unsuitable for this purpose. Moreover, the dust in such gas was an obstacle against its use so that in a way the advancement of the gas engine was further retarded until suitable gas-washing apparatus could be invented.

The John Cockerill Co., of Liége, Belgium, probably made the first installation to demonstrate the practicability of using blast-furnace gas in a gas engine. This installation was made at the furnaces at Seraing and consisted of a single-acting, single-cylinder unit of 300 hp. The gas as it came from the furnaces contained only a small amount of dust, and it was not thought necessary to wash it.

The next installation, made by the same company, was at Differdingen and consisted of nine single-acting, single-cylinder engines of 600 hp. each. Both of these installations gave considerable trouble, due largely to the dust in the gas which cut the cylinders and pistons badly. These troubles finally drove the Differdingen firm to the development of a gas washer and, after several costly experiments, they found a centrifugal fan with a spray of water played into it to be the most satisfactory.

Later the installation at Seraing was succeeded by a single-acting, tandem, two-cylinder engine of 750 hp. at which time a Theisen gas washer was also installed. The installation of this unit and the experience gained from it led to the later development of the double-acting, tandem, two-cylinder engine and from that to the modern twin-tandem, double-acting, four-stroke-cycle machine.

During this time the only other builder of the four-stroke-cycle type, in large sizes, was the Nürnberg Co., which seemingly kept pace with the Cockerill Co. At the same time, however, the Otto Gas Engine Co. was developing an engine practically along the same lines but in the smaller sizes only. This company apparently was rather conservative, although it adopted the double-acting, tandem type almost at the same time that the Cockerill and Nürnberg companies did, all three working on the four-stroke-cycle principle.

There are, of course, many builders of large and small gas engines in Europe, other than those mentioned, but the majority are either licensees of these companies or have adopted their general design but are exploiting some special features such, for example, as the Crossley engine of England. This is practically a single-acting, four-stroke-cycle engine of the Otto type, except that it has a balanced exhaust valve.

Another form of the Otto four-stroke-cycle engine was invented by a Mr. Lateme, of Paris, which for a time was favorably considered and which received first prize at the Paris Exposition in 1900. The distinguishing feature in this engine was that it had a greater compression for the light loads than for the heavy loads, thus giving better combustion under reduced load conditions. There were, however, certain objections and disadvantages which prevented its general adoption. Still another form of this same Otto four-stroke-cycle engine was the Premier, built near Nottingham, Eng. The special feature of this engine consisted of a small auxiliary air pump intended to scavenge the waste gases from the clearance space before admitting the charge. This was done by opening the inlet valve on the exhaust stroke a little in advance of the closing of the exhaust valve so that the air, under pressure in the receiver between the inlet valve and the air pump, rushed in and scavenged the waste gases and cooled the surfaces of the cylinder head and piston, thereby increasing the capacity and efficiency of the engine.

Development in America

In this country the development of the gas engine has not been carried on as aggressively as in England and

Germany. While we have many builders of gas engines in the smaller sizes, it is only within recent years that the large units have received much attention. For example, the Westinghouse Machine Co. has built gas engines up to 200 and 300 hp. for some years but only within the past few years has it put out the larger-sized machines. This company now has some large engines in operation, including blowing engines, all of which are of the double-acting, tandem, four-stroke-cycle type.

The Snow Steam Pump Co. probably deserves the credit of being the first American concern to build successfully large modern gas engines. The design adopted is the tandem, double-acting, four-stroke cycle with the valves on the cylinder body at the side and placed in a chamber. In the last respect only does it differ from the standard modern type of engine. This company has built and has in successful operation units as large as 5000 hp.

Among other manufacturers are the Allis-Chalmers Co., which is the licensee of the Nürnberg engine, of which a number of large sizes have been built, and the De La Vergne Co., of New York City, which builds the Koerting two-stroke-cycle and four-stroke-cycle engines. Practically all of the other and smaller builders have adopted the standard tandem, double-acting, four-stroke-cycle design with the valves on the cylinder body, the inlet on top and the exhaust underneath.

In the earliest types of gas engines the charge was ignited at atmospheric pressure only; that is, there was no compression. About 1860, however, it was discovered by experiment that by compressing the charge before ignition a greater efficiency as well as capacity could be obtained. The result is that today all modern engines compress the charge from 100 to 150 lb. per sq.in. before ignition, the amount of compression depending largely upon the gas.

In the same way has the governing arrangement been improved upon. Formerly the engines were controlled by the hit-and-miss method of regulation; that is, at full load the engine exploded a full charge at every cycle, but as the load was reduced, the power stroke would be omitted now and then by the governor not admitting any gas. This was probably the most efficient form of governing from the standpoint of economy, but it gave poor regulation and necessitated large flywheels; consequently the later designs are so arranged that the amount of the effective charge is lessened for reduced loads. This may be done in several ways, one of which is to change the quality of the mixture by throttling the gas only. The objection to this method of governing is that the mixture may become so lean on light loads as to impair its ignition.

Another method of regulation is by throttling the quantity of the mixture and leaving the proportions of air to gas constant. To maintain a mixture of constant proportions for all loads is very desirable yet, on the other hand, this plan has a tendency to reduce the compression on the light loads and thus cause poor combustion. To overcome the objections to both of these methods, various combinations and forms of stratification have been resorted to; these involve a somewhat more complicated mechanism. As to which is the best method, is a matter of opinion, and there is undoubtedly room for further improvement in this particular phase of gas-engine design.

CORRESPONDENCE

Gas Engine Cylinder Lubrication

L. L. Brewster, in the Mar. 11 issue, seems to have overlooked some points in his criticism of A. L. Brennan's article on "Gas Engine Cylinder Lubrication." Mr. Brennan says: "The first indications in the case of using a poor oil are manifest in decreased power, due primarily to the friction offered the surfaces of the piston and cylinder; secondly, to faulty compression, due to the piston rings becoming inoperative, and, thirdly, to carbon deposits, which materially reduce the efficiency of the valves and impair the function of the spark plugs." To this Mr. Brewster replies: "I have yet to see one (an engine) in which I could discover a case of improper cylinder lubrication by a decrease in the power developed."

I would say that Mr. Brennan is right, except, perhaps, in a very few instances. In my experience, covering a period of nine years, with almost all makes of gas and oil engines, ranging from 65 to 500 hp., I have found that improper lubrication of the cylinder will cause a decrease in the power developed. For instance, in using an oil with a heavy body and of a low fire test, one is apt to get a large amount of carbon. This will cause the engine to miss fire by accumulating on the spark plugs. Also, carbon and burned oil will deposit around the valve seats, preventing the valves from seating properly, and there will be a loss of compression through the exhaust or the engine is apt to backfire through the intake. This will, as a rule, cause a decrease in power; in fact, I have known it in certain cases actually to stop the engine.

In using an oil that is too thin, one is apt to have trouble with the engine heating up. This, as a rule, causes the engine to slow down, and the power to decrease. Furthermore, the excessive heat may thin the oil until it is not sufficient to keep the piston from rubbing the cylinder walls, and it is liable to score them; as a result the piston may seize.

In an engine with a badly worn cylinder and rings the thin oil will blow out and the cylinder will not get its surface covered enough to properly lubricate it, nor to hold compression. This will cause perceptible loss of power. I have had the oil gum so that it was almost like tar; and it would retard the action of the piston to such an extent as to cause the engine to slow down and gradually stop. In most instances this can be prevented by a careful engineer through attention to the lubricator or by a quick change of oil. Of course, conditions vary in the different engine rooms, so it is hard to tell just what can be done. But I have, several times, saved a shutdown on account of poor oil, by getting busy as soon as the engine began to show any symptoms of defective oiling.

L. T. Durman.

Geddes, S. D.

Dugald Clerk, says "The Mechanical Engineer," has recently devised a scheme to prevent preignitions in gas engines using coke-oven gas, which is high in hydrogen, by introducing cooled exhaust gases into the inlet pipe and thus diluting the gas. It is claimed that this does not materially decrease the power of the engine.

HEATING AND VENTILATION

Some Troubles of Steam Heating Systems

By Charles H. Bromley

Drawing the air from steam-heating systems by means of a vacuum pump aids in the operation of the plant, and where insufficient radiation has been provided it often makes it possible to maintain comfortable temperatures in the rooms during periods when the load on the engines and other steam-consuming units is normal. During periods of low load or very low temperatures, the exhaust is usually inadequate and the addition of live steam is required.

At night when the engines are shut down, it is common practice to supply live steam at boiler pressure through a large live-steam line from the header direct into the main exhaust or trunk line of the heating system. Where the system is compact and the boilers are centrally located, this one large connection will prove satisfactory. But where the system is distributed over a wide area, and especially in buildings of the usual skyscraper height, say eight or more stories, the one connection is not wholly satisfactory.

In most office buildings the load drops considerably just at the time the outside temperature is falling Almost immediately the pressure in the heating system drops to a vacuum and the valve in the live-steam connection must be opened more and more as the load and temperature continue to fall. To fill a large system quickly from one source of supply entails exceedingly hard work on the part of the fireman as the steam is condensed long before it gets to the extreme ends of the system. This condition is so bad in some plants that firing the boilers on the night watches is almost unbearable.

To obviate such troubles and to secure good regulation of the system, two live-steam lines of 1 to 2½ in. diameter each, depending upon the arrangement of the heating system, should be connected to the branch mains at the extreme ends of the system.

Vacuum Troubles

The air-relief valves are the greatest source of trouble. Everyone is familiar with the manner of adjusting these valves, but because it is a simple operation, many are too careless in adjusting them properly. In most cases they are not adjusted close enough, so that steam is constantly being blown into the vacuum lines. This disintegrates the valve pencil or so coats it with dirt as to close the valve tight, and when a screwdriver is applied to open it, the valve is frequently stuck fast. If too much force is used in trying to back off on the pencil, the brass cap unscrews, leaving the pencil stuck in the valve. When this happens the quickest way to remove it is to take off the valve and, holding it in a pair of gas pliers, drill out the pencil, being careful not to drill into the valve seat.

Plugged Vacuum Lines

It is chiefly because the air valves are not adjusted close enough that troubles from plugged and corroded vacuum lines are experienced. The first step is to locate the obstruction, which may be done by trying for vacuum on the floors above and below the radiators affected. The seat of the trouble, if in the local line or the riser, may be readily located, and if in the former, disconnect the short pipe between the air valve and the elbow or tee, for the trouble is likely to be here, and in this event the obstruction can be quickly and easily removed.

If the riser is plugged so badly that there is insufficient vacuum, the line must be washed out by using a hydraulic force pump. Locate the riser in the basement and make provision for a nipple and hose connection to it, even sawing the line if necessary. This is a disagreeable job at best, for it is often necessary to lie cramped over hot pipes and sometimes there is only room to use the blade of the saw.

Pails of water and hose lengths for connecting to the suction and discharge sides of the pump should now be obtained. The hose on the discharge side should be of good quality and able to withstand high pressures. Connect the discharge hose to the riser and somewhere above the obstruction open the line, i.e., disconnect it at a radiator (one in a toilet is preferable), attach a piece of hose and have pails ready to catch the water as it is pumped up through the line by the men operating the force pump. Hot water is best as it softens the matter in the pipe.

There should be plenty of leverage on the force pump so as to facilitate pumping under high pressures. It is well to connect a pressure gage to the pump to eliminate guesswork as to the pressure applied. When high pressures have been repeatedly put on the line from below and above the obstruction and the latter is not removed, the line must be taken apart to be cleared.

Air Bound Coils

In indirect systems using four or five large manifold coils for tempering and heating the air, trouble is sometimes experienced on account of the coil not heating throughout. This allows large volumes of cold air to pass through the coil and on into the rooms. This condition is sometimes so bad that, where air-washing systems are used, the water from the spray pipes freezes, forming large icicles, and iced air is passed into the rooms. The trouble is due chiefly to the vacuum pipe being plugged or too small, so that air remains in the coils, to the coil return being full of water or to a shortage of steam. It can be eliminated by putting a tee in the vacuum line and connecting a branch to the front part of the return header as at *A* in Fig. 1, in which *B* is a sheet-iron filler box and *C* is the doorway to the housing.

Adjusting Thermostat

When the coils are thermostatically controlled, as they usually are, and icicles form in the air-washer hous-

ing, the thermostat regulator should be thrown over to the "warmer" side, and left there. This will allow steam to flow through the coils continually and quickly melt the ice. If the main air intake duct contains a door or slide opening between the outside inlet and the air washer, it should be opened to allow the warm air of the basement or room to be drawn in. This will greatly aid in melting the ice. If there is no such opening in the inlet duct one should be provided. The door to the air-washer housing should also be opened at such times, the aim being to pass warm instead of cold air to the coils and washer.

Air and Diaphragm Troubles

Hot air is sometimes passed into the rooms for too long a period and the heat becomes unbearable. When

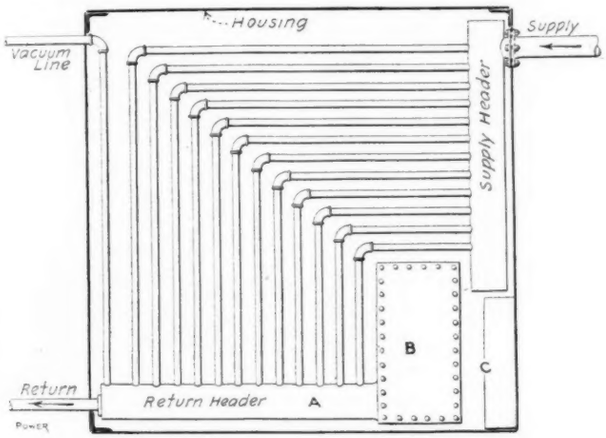


Fig. 1. Heating Coil in Housing

this trouble is general throughout the system it indicates that the pressure of the compressed-air supply to the thermostats and diaphragm valves has fallen, or perhaps the air pump has stopped. When the trouble is confined to only one coil it denotes that the diaphragm *D*. Fig. 2, is leaking, so that the spring *E* holds the valve open. It is then necessary to regulate the steam and temperature by hand while putting in a new diaphragm, a number of which should be kept on hand.

Where the plant uses high-pressure air for water lifts or other purposes, it is best to let the small low-pressure air pumps for the thermostat air supply lay idle and take air for this purpose from the high-pressure receiver through a reducing valve. The air pressure for the thermostats should be 15 lb. per sq.in.

Thermostats

Perhaps most thermostatic troubles are due to meddlers who must "see how it works," and these meddlers are usually men of the engine-room force. One man should have charge of these devices and no others should meddle with them. It is a tedious job to properly adjust a thermostat and to have the adjustments frequently disturbed should not be tolerated.

The chief point about the operation of thermostats is to keep the air supply to them dry and clean, so that the small openings at the needle valves and also the cotton filter will not become plugged. The joints (those having lead gaskets are best) should be kept tight, as small leaks prevent fine adjustment. In justice to the thermostat let it be understood that with proper care it can be made to operate on half a degree temperature variation.

Where thermostats control the steam supply to large coils, the device should be made to operate at a temperature about seven degrees higher than is desired in the rooms. The reason for this is that the coils do not get hot for some time after the steam valve has opened, and by the time the coils have become heated, the room temperature will have dropped considerably below that desired. When the thermostat operates the valve at about seven degrees higher than the desired room temperature, the heat reaches the rooms just before the temperature therein has reached the lowest desirable point. As the thermostat operates in advance of the room-temperature extremes, it will have closed the steam valve before the room temperature is as high as it should be. But the coils at this time contain enough heat to raise the temperature to the desired degree, and the fan will continue to blow this heat into the rooms. By being careful in making the adjustments, and if the rooms are also provided with thermostatically controlled direct radiators, as they should be, the room temperature can be kept almost constant.

Making People Warm without Heat

The most common error in steam-heating installations is that not enough radiation is provided to make the rooms warm enough in severe weather. During these cold

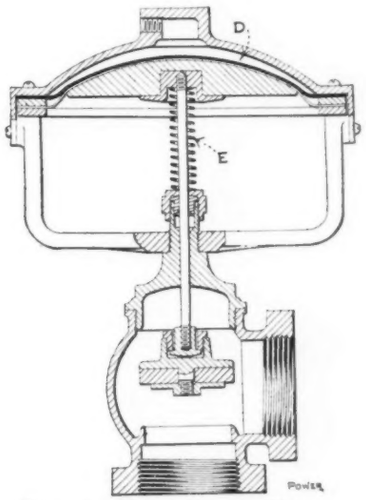


Fig. 2. Diaphragm Valve

intervals the system is carrying as much pressure as it can safely withstand and all radiators are as hot as it is possible to make them. Nevertheless, demands for more heat keep the telephone busy. The man at the 'phone must be courteous and assure the complainants that more heat will be forthcoming and if possible call immediately at the rooms from which the complaints are received, as immediate attention in a case of this kind goes a long way.

Monday morning gives the most trouble, due to dropping the temperature over Sunday and then trying to raise it at the last moment. In rooms where many girls, whose work requires them to sit at desks or do little physical exercise, are employed, one thin-blooded person, by putting on her coat, will make every girl in the room shiver with cold. Complaints will come in and the wise heating man, when he enters the room in response will

agree with the occupants that it is uncomfortably cold, and proceed to inspect every radiator, suggesting to each girl as he goes along that if she gets too warm she may shut off the radiator. On leaving, he should assure the lady in charge that more steam will be turned on and the room made very comfortable in half an hour. In the meantime other complaints must be attended to and that room forgotten, as more heat cannot be sent to it when the system is working at its greatest capacity.

When he returns he should smilingly remark how comfortable the room is, and then (this is the important part) talk heat to the lady-in-charge until she takes off her coat. She will do it, and when she does, one by one each girl will take off hers and all will become warm as quickly as they became cold.

Of course, the above is a poor way to supply heat, but it is the best substitute for radiators and must be applied until they can be installed, which should be as soon as possible.

A New Hot-Water Heating System

Notwithstanding its acknowledged advantages, heating by hot water is often considered impracticable on account of the initial expense by reason of the larger piping required when the gravity system is used, and the impracticability of the forced-circulation system for small installations. Attempts have been made to increase the circulation by applying heat to the risers, but this has proved impracticable on account of the impossibility of regulation from a central point and the high fuel expense.

Herr Herman Kraus, engineer of the German Museum in Munich, has conceived the idea of increasing the circulation by injecting air into the risers, the air subsequently escaping through the expansion tank. The air for a large installation can be compressed by a small motor-driven compressor at the expense of a few cents per day. When compressed air is already available the advantages are all the more manifest. This system permits the use of small piping, is controllable from a central point, and will recommend itself for many installations on account of its simplicity.

Coal Required for Heating

By W. L. Durand

The coal consumption of a low-pressure heating apparatus is often desired at the time of designing the system and may easily be ascertained to a close degree of accuracy by the following method.

Pea coal, which is the size in most common use, contains about 12,000 B.t.u. per lb. Not over 8000 B.t.u. is absorbed by the boiler and with a 10 per cent. loss in the heating system the heat delivered at the radiator per pound of coal is about 7200 B.t.u.

Each square foot of direct steam radiation requires 250 B.t.u. per hr. for zero weather. For New York City about 45 per cent. of this maximum will be required for the heating season of 210 days. In other localities this factor will be different and may be determined by taking the ratio of 70 minus the average temperature of the heating season to 70.

$$250 \times 24 \times 210 \times 0.45 = 567{,}000 \text{ } B.t.u.$$

$$\frac{567{,}000}{7200} = 78.75 \text{ } lb.$$

or practically 80 lb. of coal per square foot per season.

There are various rules for determining the coal consumption, but they are all open to objections and do not give accurate results. The following apply to New York City:

1. *Grate area multiplied by 4.4 equals tons of coal burned per season.*

2. *Each cubic foot of contents will require 0.9 pound of coal per heating season.*

3. $$\frac{\frac{\textit{Exposed wall surface}}{4.5} + 2 \times \textit{glass surface}}{100} = \textit{tons of coal per heating season}$$

The first rule is practically of no value since the rate of burning coal per square foot of grate surface may easily vary by 100 per cent.

The second is only approximate as the ratio of heating surface to volume may vary anywhere from 60 to 1 to 100 to 1.

The third is probably the most accurate of all as it is based on the heat losses from the walls with an allowance for air change, but would be in error as the ratio of the exposed surface to the volume is far from being a constant.

The method outlined at the beginning should be more accurate, for the heat required per season is first determined and then the coal necessary to supply this heat. This figure of 80 lb. per sq.ft. of heating surface may vary where other coal is used or the efficiency of the boiler differs, but the method is the same and if the proper factors for any particular case are used the estimated and actual coal consumed will be found to be very close.

Heating Building with Waste Heat from Gas Engine

A simple expedient for use at the plant of the Ford Motor Co., Detroit, Mich., has been designed by Edward Gray, for taking advantage of the waste heat of the exhaust gases and the jacket water. This is done by the use of tubular heaters. The jacket water from the engine is circulated by a pump through the heater and back through the engine jacket, giving up its heat through the tubes to the water in the heating system. After leaving this heater the water for the heating system may be passed through a second heater, to which heat is supplied by the exhaust from the engine.

The pressure in the primary heater is on one side that due to the static head existing in the heating system. The jacket water circulated is under a pressure due only to the head necessary to circulate the water, and this may be very small. The primary heater may be of simple construction; in fact, one of the several standard forms of feed-water heaters will serve the purpose very nicely.

The secondary heater, through which the exhaust gases pass, should be constructed of such material as will withstand the possible corrosive action of the exhaust gases, and should, preferably, be of cast iron.

New York City. L. L. Brewster.

EDITORIALS

Boiler Joints

An abstract of an interesting paper, describing tests made to determine the maximum fiber strains produced in the shell plates of boilers in the vicinity of lap joints, will be found on page 518 of this issue. It has been suggested in these columns before, that it would be a step in the right direction if some of our states having boiler laws would devote a small part of the large sums expended directly and indirectly in the enactment and enforcement of boiler legislation to a scientific investigation of the causes of boiler failures of the more common kind.

The lap-joint crack may be safely said to be one of the most, if not the most, prominent causes of disastrous boiler explosions.

While it has been contended for many years that the lap-joint crack is produced by a repeated deformation of the joint, due to changes of pressure (and this is doubtless a correct statement of fact) it has remained for some progressive engineers in far-away Australia to actually demonstrate the intensity of the surface stresses that may be produced in the plate by this means with lap joints.

These tests were undertaken and carried out without government aid, so far as we are aware. They were evidently conducted in the most painstaking manner, and the results obtained are remarkable in their agreement with the theoretical analysis that may be made respecting the maximum stresses to be expected in the plate adjacent to a lap-riveted joint, but it is evident that only the surface of the subject has been touched.

A few years ago the lap joint alone was commonly believed likely to develop defects of this character, but more recent experiences have shown that the butt joint is by no means immune. There have been numerous instances of similar failures in butt-joint boilers throughout the United States during the last few years, but fortunately, to the best of our knowledge, none has resulted in an explosion.

On Aug. 9 of last year, a Scotch boiler on the steamship "Guttenberg" exploded at Rotterdam, Germany, with great violence. This boiler was constructed with a butt joint, and the initial failure was through a crack along the outer row of rivets, which exhibited all the characteristics of the so called "lap-joint crack."

As long as cracks tend to form with this type of joint, it will only be a question of time before other serious explosions are recorded, due to this cause. It would seem that the proper state authorities might take up the work so admirably commenced by these engineers, and demonstrate conclusively why boiler joints of both types tend to crack. Massachusetts boiler laws have done much good by partly prohibiting the use of lap joints, but much remains to be accomplished.

Only the knowledge of how accidents occur can indicate the measures to be adopted to prevent their recurrance. Let us obtain this knowledge with respect to boiler joints before making further rules.

A Municipal Power-Cost Investigation

The year's test which is now being conducted on the plant of the Hall of Records will go a long way toward settling the controversy as to whether it is more economical for New York City to operate isolated plants in its public buildings or to purchase central station current.

This test is the consummation of an investigation begun about two years ago by the Bureau of Municipal Research into the shutting down of several well-equipped city plants and the substitution of central station service. This investigation had the active support of Borough President McAneny.

In this work the Bureau of Municipal Research made a study of the cost of heat and power in a large number of private plants throughout the city and compiled a very comprehensive report. This, however, was attacked by the central station advocates on the ground that certain assumptions had been made in regard to exhaust steam heating.

About this time the question of power for the new municipal building came up. Its proximity to the Hall of Records, the available space in that building, and the fact that its plant was not working up to full capacity, afforded an excellent opportunity for a central plant supplying both buildings by adding to the existing equipment. This plan was strongly advocated by the engineering staff of President McAneny's department. Naturally it met strong opposition from the other side.

It was finally decided to make a year's test of the Hall of Records plant, which would include the loads at all seasons. The test is under the personal direction of Professor Diederichs of Cornell University and the results will be submitted to a board of six supervising engineers; two representing the Bureau of Municipal Research; two the City and two the New York Edison Co.

The outcome of the test is of vital importance to the operating engineers as well as to the city; for should it be adverse to the isolated plant it would affect the positions of many employed in city plants.

⁂

The Flood

It is good to be able to say that the flood disasters in the Middle West are not so serious as at first reported. While the loss of life will undoubtedly be in the hundreds, it is far below the early estimates. In Ohio and Indiana, the public utilities, factories and agricultural interests have suffered the most damage.

Too much cannot be said in praise of the manufacturing and supply people and the operating companies of other sections, for without their quick assistance many power stations would still be helpless.

The loyalty and heroism of the managers and operatives in the flooded districts preserved many public utilities from irreparable loss. This devotion to duty is all the more praiseworthy as many of these men were not only in grave danger while sticking to their posts, but they

were ignorant of the safety of their families and homes, and still they toiled bravely on.

In one Indiana lighting plant the water rose to within an inch of the fire-doors, the pump and condenser pits were filled, and, says the press report, "in spite of all this the plant gave continuous service throughout the perilous period." Many of the men worked sixty and seventy hours so that their townsmen and the industrial interests would not suffer a greater than water damage, and the cities and towns officials are most outspoken in their admiration of the steadfastness of these men who, under normal conditions, are seldom given any public recognition.

The optimism and resourcefulness of the people of the Middle West can do much, but their task of rehabilitation would be far more difficult if outside assistance had not come from other sections. POWER's cartoon on page 515, "Answering the Call of Industrial Distress," portrays, we believe, a vivid picture of that army of eager industrial soldiers which marched to the relief of the storm-stricken cities.

We are a hopeful, open-hearted nation, and in the hour of need we stand ready to give of our time, our skill and our money, feeling that our well-doing is sufficient compensation therefor.

❋

Water-Power Development by New York State

Whether New York is to commit itself to a policy of state ownership and operation of power plants is now a bone of contention at Albany. The Murtaugh bill now before the legislature provides for the appropriation of six hundred and thirty-five thousand dollars for the construction of hydro-electric plants at the new barge-canal dams in the Mohawk River at Crescent and Vischers Ferry, the power to be transmitted to Albany, Troy, Cohoes and several adjacent towns.

According to the engineers of the Conservation Commission who have carefully studied the problem, it will be possible to develop three thousand horsepower continuously at each dam, and with suitable pondage facilities six thousand horsepower could be produced at each place (a total of twelve thousand horsepower) for use during the hours of peak load, for every day in the year. Moreover, the flow is said to be such as to make available power considerably in excess of this during ten months of the year, and with an auxiliary steam plant to help out during the dry season the capacity could be greatly increased.

As would be expected, the large private power interests are actively opposing the passage of the bill. Through a committee of the National Electric Light Association, of which Arthur Williams is chairman, they have protested before the legislature in an effort to show that the figures of the Conservation Commission's engineers are incorrect, that the available flow would not warrant the installation of a hydro-electric plant, and that the state would be the loser.

This might be mistaken for a splendid example of public spiritedness were it not for the fact that the same committee recommends, as a substitute, legislation permitting the sale of this and other state water powers at *public auction* to private interests. Surely if the flow is not such as to warrant state development we fail to see how, except by a miracle, it could be increased under private exploitation.

As to the expediency of state or municipal ownership of power plants, opinion is divided. Many claim that it is impossible to keep such undertakings free from political influenes, yet in Europe and in certain cities in the West and South we have excellent examples of what can be accomplished through efficient municipal operation.

Again, some contend that a public-utility corporation operating under franchise in a certain locality and in compliance with local regulations should be protected against competition. This is reasonable so long as the company continues to give adequate service at reasonable rates and does not attempt discrimination. The people should retain the right, however, to step in with their own plant just as soon as any of these provisions are violated. While it might not always be advisable to exercise this prerogative, it would serve as a powerful weapon in the hands of the people to guard against breach of faith on the part of public-utility corporations.

❋

In Denver, Colo., the Citizens' Protective League has been organized "to elevate the tone and moral standards of the newspapers of Colorado."

Denver is some distance from our easy chair and we are not familiar with the "vicious journalism" that brought this league into existence. We can well imagine, however, that the conditions were unbearable, for only then can the public be aroused to action. If public sentiment could only be stirred up in behalf of legislation in our different states respecting boiler inspection and engineers' licensing, what a big thing it would be for safety to life and property.

❋

While it cites an exaggerated instance of incompetency, the letter on page 537, "Example of Poor Engineering," by analogy, is an argument for licensing engineers and inspecting boilers. Evidently state legislation might even be extended to cover hot-house installations. At any rate the experience should serve as a warning to anyone putting in a steam plant of any kind that it is economy in the long run to employ qualified designers and contractors.

❋

The story is told of an engineer who complained that recent shipments of coal received were not near as good as previous shipments. He insisted on an explanation and the coal dealer informed him as follows:

"Most of my customers up your way purchase their coal on a heat-value basis and, of course, they rejected their last lot, so I had to send it to you, who I knew purchased without testing."

❋

The English author of the article on "Some Notable Boiler Explosions," in our issue of Dec. 10, evidently had not read the entire story of the water-tube boiler explosion at St. Louis some years ago. It was shown in POWER at the time that the initial break occurred, not in the boilers themselves, but in a large header to which they were connected, and upon which a gang of men were at work when the explosion occurred. Subsequent expert examination confirmed this conclusion.

READERS WITH SOMETHING TO SAY

Example of Poor Engineering

An example of what can happen when incompetent men lay out even a small plant is given in the following:

For heating four large greenhouses, there were three boilers, each 12 ft. by 52 in., fitted with ball-and-lever safety valves set to blow at 50 lb.

Unfortunately, the pipe work was done by a plumber whose knowledge of steam fitting was limited. As there was no provision for connecting the feed-water line to the boilers, he connected it to the bottom of the water columns. There was no blow-down pipe attached to the columns, but a pet-cock on the bottom gage-glass cock was used for this purpose. This manner of piping was suggested by the architect who built the greenhouses. On finding that the water level disappeared in the glass while feeding, they piped the line in through the blow-off connection.

Later the boilers and piping were put in service to test for leaks. The main run of piping was over 600 ft. long, and as no provision for expansion had been made, the end of the greenhouse was pushed out and nearly every joint caused to leak badly. No traps were installed to assist in caring for the returns. The return water was so hot that the pump slipped and slammed constantly while handling it.

As the stack at this plant was very short, the draft was furnished by two gas engine-driven fans. But with these fans the draft was so strong that the fire-doors soon warped so badly that they could not be closed tightly, thus admitting too much air over the fire.

The result of this installation was that the entire plant had to be remodeled at considerable expense, all of which could have been avoided by securing competent engineers to supervise the original installation.

J. M. Owen.

South Weymouth, Mass.

Care of Oil Piping

Most engines in modern power plants are provided with an oiling system which may give trouble from the overflowing of the oil onto the floor or into the flywheel and over the generator. The feed lines generally give less trouble than the returns, probably because the oil is usually under a head or pressure of several pounds This alone is enough to wash away small obstructions. Another reason is, that the oil has just been filtered and if the supply tank has a cover there is little chance for dirt to get into the line.

When certain grades of oil are used, it sometimes happens that sediment forms in the pockets of the feed lines, obstructing the flow. If possible the piping should be arranged to eliminate pockets, but in existing pipe lines a suitable blowoff can often be placed at the troublesome point to remove the sediment from time to time.

Fig. 1 shows a case that came under my observation where the horizontal line *A* became plugged with a thick substance which could be removed only by drawing a swab on a wire through the pipe. Placing a blowoff at *B* relieved the trouble.

When the engines are located in a mill or other exposed place, the oil will often congeal in cold weather and clog the pipes. A small steam coil in the supply tank will tend to relieve this trouble. Care should be taken

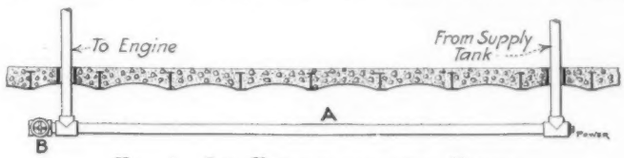


Fig. 1. Oil Piping through Floor

not to let the oil get too hot as it will lose its viscosity, and some of it may be evaporated and form an explosive vapor.

In some cases a small steam pipe is placed along both sides of the oil line as in Fig. 2. The steam piping, however, often gives as much trouble as the oil line itself. There is so much more piping to dismantle when making repairs, and the small leaks are a constant annoyance. In severe weather I have seen a ¼-in. steam pipe freeze at the low point of the line. As the pipes for the most part are hot, they interfere with wiping the engine.

Another point to remember is to avoid the use of rubber, as leaks are sure to develop. Sometimes these leaks are under the floor out of sight so that a large loss of

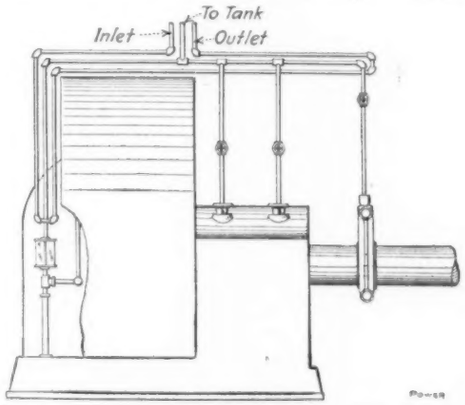


Fig. 2. Steam Piping to Keep Oil Warm

oil is possible before the leak is detected. There are several types of unions on the market having brass seats, and for flanges sheet lead makes an excellent joint.

The drain lines of an engine generally give the most trouble from stopping up and causing the oil basin or crankpit to overflow. Wherever possible long bends should be used. When the piping is to conform to the shape of the engine or foundations use a cross with two plugs instead of an ell or a tee with one plug. It will then be possible to blow out obstructions with an air hose, steam jet or even an ordinary hand bellows.

Oil piping should never be imbedded in cement floors. Where the piping passes through the floor, a piece of pipe of larger diameter should be inserted. The cement is then imbedded against the outer pipe and the oil line can be readily removed when necessary.

A great deal of trouble from plugged drains can be avoided by frequent cleaning of the pits under the crank and eccentric and back of the guides. Small pieces of packing will sometimes blow out and bits of waste fall in while wiping. A piece of screen over the end of the pipe will stop much of it from entering the pipes.

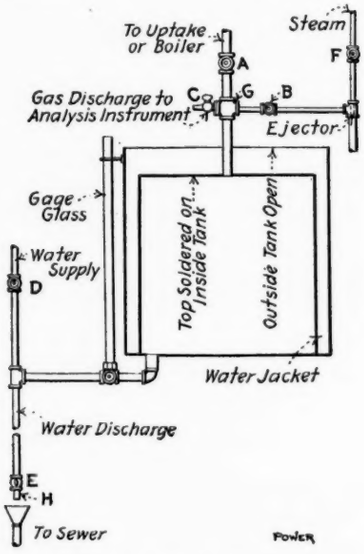
LEE GRANDMONTAGUE.

Youngstown, Ohio.

Flue-Gas Sampler

In our boiler room is a galvanized-iron, flue-gas sampler that is not expensive to make and collects a fairly average gas sample.

The outer tank is 2 in. larger in diameter and 1½ in. higher than the inner one. This allows 1 in. of water around and on top of the inner tank for a water jacket.



FLUE-GAS SAMPLER

One bottom answers for both tanks. If it is set on a wood shelf without any large cracks between the boards, the shelf will act as an insulator for the bottom.

Water is admitted and discharged through a connection at the bottom; gas is drawn in and discharged through a connection at the top. To fill with water, either valve *A*, *B* or *C* is opened and the valve *E* is closed, then the valve *D* is opened. Water will rise in the gage-glass as the tank fills. The top of the glass should be a little higher than the top of the inner tank, but not as high as the cross tee *G*. This will allow the water to overflow through the glass if *D* is left open too long without letting the oil film, which is maintained between the gas and water, to waste away through the valves *A*, *B* or *C*. This arrangement also prevents the operator from rupturing the tank by an excessive water pressure if the valve *D* were opened when the valves *A*, *B*, *C*, and cock *E* were closed.

To put the sampler in operation after the tank is filled with water, the valve *A* is opened and the pet-cock *C* closed, then the ejector is started by opening the valves *F* and *B*. By observing the water level in the gage-glass before and after opening the valve *B*, it is easy to determine the vacuum created by the ejector. After the ejector has discharged all the air, the valves *B* and *F* are closed and the valve *E* opened.

A short piece of pipe *H* is threaded on one end and plugged with soft metal. The plug has a small hole drilled through it, the diameter depending upon the rate at which the water is to be discharged from the tank. We have a set of these parts with various sizes of holes tested for various lengths of time, so that while operating the cock *E* is left wide open.

To draw out a sample for analysis the cock *E* and valve *A* are closed. The analysis instrument is connected to the cock *C* and when the valve *D* is opened enough to raise the water in the gage-glass a little, it puts a slight pressure on the gas and, by opening the cock *C*, the gas is forced to the instrument.

As there are no means for maintaining a constant discharge of gas, the discharge line should be made as long as possible. This makes a smaller proportional difference in pressure, due to the varying head of water in the tank.

The ejector was made by soldering the end of a seamless spout into the end of a ¼ and ⅜ by ¼-in. tee.

L. B. CASE.

Plainfield, N. J.

Available CO_2 Percentages

During the past year a number of articles have appeared in POWER relative to flue-gas analysis. The various writers mentioned results they obtained and the percentages of CO_2 they secured, but failed to mention how a certain percentage in a certain plant burning a certain grade of fuel is determined.

Nor did the articles I have read mention the relation of CO_2 to any particular grade of coal. There are a number of engineers who are commencing to use the Orsat apparatus or flue-gas recorders, and who are trying to obtain some of the percentages they have been reading about, without knowing that that percentage is not in the grade of fuel that they are using. They are trying to get something that is not there.

A quantity of pure carbon burned under laboratory conditions would only result in 21 per cent. CO_2, in other words, 21 per cent. is the theoretical maximum percentage of CO_2. The theoretical percentage of CO_2 in a given grade of coal, can be determined approximately, by multiplying the theoretical maximum (21) by the percentage of fixed carbon in the fuel. Thus, a grade of coal containing 70 per cent. fixed carbon has approximately

$$0.70 \times 21 = 14.7 \text{ per cent. } CO_2$$

The percentage of CO_2 that should result from the above sample of coal under everyday conditions, would then have to be determined by practical experience. I would say with tight boiler settings, properly designed furnaces and good judgment on the part of the fireman, 10 per cent. would be a good everyday average for the sample mentioned.

It must also be remembered that the percentage of CO_2 in itself, is not always an indication of efficiency. There may also be present CO or carbon monoxide. The pres-

ence of this gas in any quantity is absolutely detrimental to efficiency. Carbon when burned to CO_2 (laboratory conditions) will give 14,500 B.t.u. per lb. approximately. When burned to CO, the result will be only about 4400 B.t.u. per lb. As the object is to obtain the greatest possible number of heat units from a fuel, it will easily be understood why CO_2 alone is no positive indication of good management or efficiency.

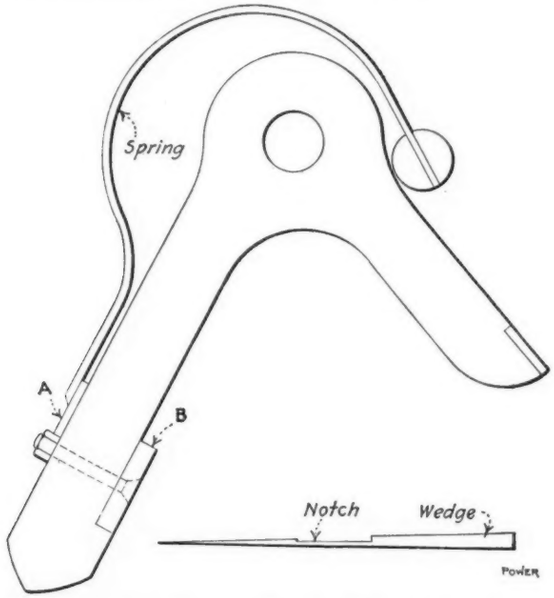
The sample should also be analyzed for CO.

Brooklyn, N. Y. A. POHLMAN.

Fixing Worn Latch Blocks

Frequently the steel latch blocks *B* on the grab-hooks of Corliss engines become worn enough to cause an intermittent valve action, which is very troublesome.

This trouble may be temporarily overcome by inserting a wooden wedge under the spring at *A*; the increased tension causes the steel latch block to engage deeper in the bell crank and the engine can be operated without interruption for a reasonable time, or until new blocks can be put in.



WEDGE UNDER SPRING MAKES WORN GRAB-HOOK BLOCK ENGAGE

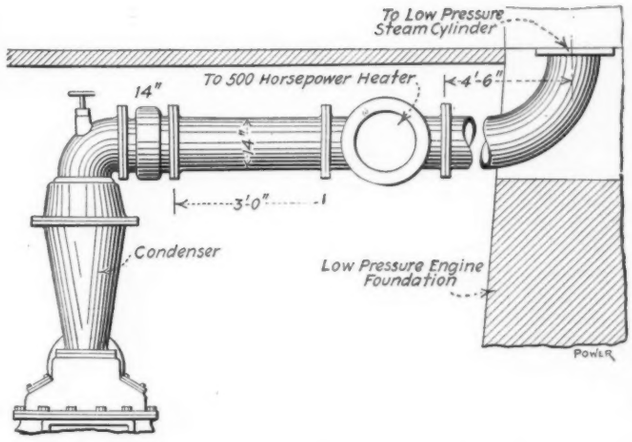
By notching the wedge, as shown, and driving it in until the spring sets in the notch, the wedge will remain under the spring indefinitely.

Louisville, Ky. J. F. HURST.

Exhaust Pipe and Vacuum Questions for Discussion

A discussion in POWER as to what constitutes a commercially tight exhaust-pipe line between the condenser and the low-pressure steam cylinder, we believe would be of interest. Also what should be the drop per minute in vacuum in this line, the engine not running, a vacuum of 26 in. existing in the pipe and the valve at the condenser closed?

We wish to secure the opinion of engineers who are considered authorities on the above subject, also to see how their opinions coincide with our own.



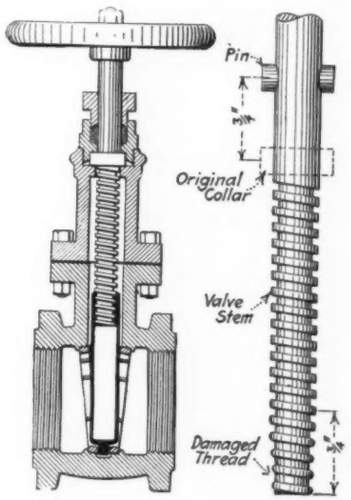
TYPICAL PIPING FROM ENGINE TO CONDENSER

The accompanying illustration shows a typical exhaust-pipe installation.

Fitchburg, Mass. W. L. BLAKE.
Blake Pump & Condenser Co.

Gate Valve Repair

In the following is described a repair to a 2½-in. gate valve used as a second valve on the blowoff pipe of a boiler, an angle valve being between it and the boiler. One day when attempting to blow down the boiler the valve would not open, although the handwheel turned freely. It was supposed that the stem was broken, but on removing the bonnet it was found that the threads at the lower end of the stud had stripped until they were useless. The stem was removed, sawed off about three-quarters of an inch from the lower end, which removed all of the damaged threads; the collar on the upper part of the stem was also removed.



HOW THE VALVE STEM WAS REPAIRED

Then a ¾-in. hole was drilled above the collar and a pin driven through it. This pin served the purpose of the collar and allowed the stem to go further down in the valve body until the threads would engage with the valve disk, as shown in the illustration.

J. J. RAMSEY.

Wellington, Kan.

QUESTIONS BEFORE THE HOUSE

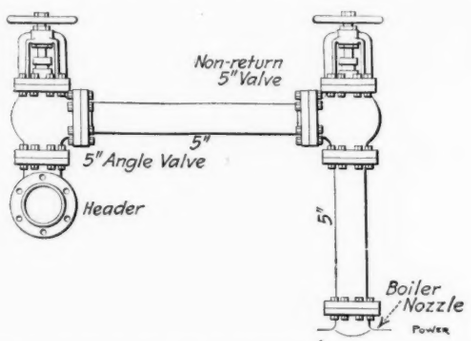
Safe Piping for Boiler Plants

The article by D. M. Meyers, under the above title, in the Dec. 10 issue, was read with interest. I believe the layout shown by him is all that he claims for it and also concur with him in his remarks on safety and efficiency.

In his illustration of the connection from the boiler to the header, there are two things with which I should deal somewhat differently. In submitting them, I wish to be understood as not criticizing Mr. Meyers, but as presenting another view.

I would use 5-in. piping and valves instead of 6 in. for the connections for the 78-in. by 20-ft. boilers. This gives a slightly more flexible construction and the first cost of material is less.

Also the 5-in. reverse-current or nonreturn stop valves will be found to give more satisfactory service on boilers of this size than the 6-in., because, being of less area through the port, the disk will rise higher from its seat



ARRANGEMENT OF LEAD FROM BOILER TO HEADER

and, combined with the more constant rate of flow of steam, there will be less tendency for the valve disk to float up and down at each stroke of the engine.

Using a valve larger than required has, to my knowledge, been the cause of several nonreturn valves of reliable make being condemned. The continual movement induced by the pulsating flow soon wears the dashpot and allows the valve to beat itself to pieces.

I have used 5-in. connections on 84-in. boilers and when working them to overload limits have failed to discover a measurable loss of pressure between the boiler and the header. For valves like that, and piping between the boiler and the header, as shown in Mr. Meyers' illustration, I prefer using two angle valves rather than globe valves, or a gate and a globe valve. Some makes of these are identical in dimensions, differing only in internal construction, adding symmetry to the job.

The advantages of this arrangement are that there are two less flanged joints, the valves taking the place of the elbows; there is a longer, hence more flexible, piece of pipe for the horizontal member, and there will be less friction with the steam passing through two angle valves than through two globe valves. Also the draining of the piping is better done at times of banked fires or dead boilers, with the nonautomatic valve left open, which is usually the practice when the automatic valve is tight, as there is a chance for water to accumulate between two globe valves on a horizontal line. A drip between the valves is a wise precaution, however, and should always be a part of the piping.

CHARLES L. WARE.

Maynard, Mass.

Efficiency and Repair Costs of Fuel Economizers

Referring to the interesting article, "When to Install a Fuel Economizer," by Everard Brown, in the Dec. 31 issue, I would offer the following comment without intending any special antagonism. Having installed many separate economizer equipments in this country during a period of 20 years, I believe I am competent to speak from the practical standpoint of experience.

Nearly every writer credits the economizer with only the theoretical efficiency, due to the heat units recovered and put into the feed water by its use, while it is seldom that the economizer saving under ordinary operating conditions does not reach a much higher percentage. George H. Barrus, after testing many plants with and without the economizer service, stated to me that he came to the conclusion that results showed that approximately 8 deg. rise in feed-water temperature equalled 1 per cent. of fuel saving. Another expert, F. W. Dean, obtained 14 per cent. saving with 125 deg. rise at another plant and many similar results by the ablest experts in the country have invariably shown the same proportion. The answer to why this is true may be readily accounted for by any of the various following reasons:

Perhaps the draft is automatically diminished for the smaller amount of fuel required with the economizer, making a consequent less excess of air and better furnace combustion. Or the reduced work on the boilers leaves them, however, with the same heating surface to perform less duty and hence they are more efficient. The purer water obtained by the use of the economizer is more efficiently evaporated. The frequent need of another boiler to supply merely an extra half or quarter boiler output, is obviated with the economizer service.

In regard to the charges against the economizer, it is not necessary to theorize, as there are 60 and more years of experience, which is enough to know accurately what these charges are.

Repairs—I recently went through my repair book, taking everything for the year, and found less than 0.2 of 1 per cent. on over two million dollars' worth of installations. Many of the machines were 20 to 30 years old. As this account included labor costs, there could be very little aside from this that the owners could have done themselves.

Attendance—Attendance is only required for blowing off daily and removing the soot once a week, which takes about two to three hours. As I have never known a case of any increase in the regular payroll for economizer work, 1 per cent. to this item would seem more than ample. Even this would seem to be offset entirely if there is less boiler cleaning and much less coal and ashes handled as is usually the case.

From the above it would seem justifiable to call repairs and attendance 2 per cent., interest 5 per cent., and depreciation 5 per cent., or 12 per cent. to cover all annual charges against the economizer cost. Economizers have been installed which have been in service night and day and have never had any attention until something happened and thus on the whole incurred more expense than others, but these were included in the whole repair account which figured as I stated, so such exceptions would clearly prove the rule to be right.

H. G. Brinckerhoff.

Boston, Mass.

Isolated Plant vs. Central Station

When the engineer becomes more familiar with the question, I cannot see why it cannot be settled definitely in favor of either the central station or the isolated plant, without argument. Although these arguments bring out facts that are of value, Mr. Lewis' statement in the Jan. 7 issue shows lack of equity. It is evident that in the building to which he refers the load conditions are peculiar, but no more so than are evident in all office-building plants, although greatly modified.

As Mr. Lewis is evidently promoting central-station interests he has to consider that the conditions mentioned also exist in the central-station load factor. If the building referred to were in Boston, something would be wrong, unless the central station gives rebates for basement room or for other privileges.

If the Boston Edison Co. were installing a 150-kw. service in the building referred to it would cost $432.50 per month, or $5190 per year, for a fixed charge, whether current were used or not, making the fixed charge $2790 more per year than the $2400 as charged against the isolated plant by Mr. Lewis, which is erroneous, because he states $20,000 represented the approximate sum total of all the material and labor which would enter into the installation of the plant. This being so, he charges 5 per cent. for depreciation and 2 per cent. for repairs on money spent for labor for which only interest should be allowed.

Then the cost of electricity, according to schedule "D" of the Boston Edison Co., which would be five cents on the first 1500 kw.-hr. and three cents for the remaining 2666 kw.-hr., would aggregate $154.98. A fixed charge of $432.50, as before stated, would give a total of $587.48 per month. This divided by the kilowatt-hours consumed would give a cost of 14c.+ per kw.-hr. This amount of electrical energy would be obtained for 10c. per kw.-hr. on a straight lighting rate. Some difference between the actual cost and Mr. Lewis' 4.8c. per kw.-hr.

More labor would be unnecessary and the extra coal used during the summer months would not be very much, because the days are long and but little light would be used. During the winter, when the peak load is noticeable, the exhaust can be partly used for heating purposes.

Various other erroneous assumptions are noticed, but what is the use of saying more.

M. W. Eastman.

Cambridge, Mass

Some interesting statements are made by Mr Lewis. For instance, he says they operate their own hydraulic steam pump, and heat the building with direct radiation. It must be taken for granted that a boiler plant is already installed, therefore, a certain amount of coal must be consumed to operate the appliances mentioned. Hence this expense cannot be charged to the electrical plant. Furthermore, Mr. Lewis says the approximate cost would be $20,000 for one 25-kw. and two 100-kw. machines. I do not know on what he bases his figures, but I am free to say that amount can be divided by two with safety and still have a margin left.

Now getting down to some kind of a basis. Say the plant requires ten tons of coal per day to operate the machinery in the building prior to the time this estimate was made, and they then install three generating machines, and produce the electrical energy used in the building, how much more coal would be consumed and how much more help would be required? According to his own figures, 50,000 kw.-hr. was purchased per year, or about 137 kw.-hr. per day, 365 days per year. With an uptodate outfit, a kilowatt-hour can be produced with 8 lb. of coal.

$$8 \times 137 = 1096 \ lb.$$

Call it 1200 lb. at $2.50 per ton; then it would be $1.50 per day. Take the cost of the new installation at $10,000 and allow 5 per cent. depreciation; this with 6 per cent. interest on the capital invested would make a final charge of $1100 for the first year. Depreciation must be credited back to the original investment and it will be less each year, consequently the first charge of $1100 must be less every year. Depreciation and interest would be about $3 per day; this added to coal cost is $4.50.

Now to be fair to the electrical end of the plant we must credit back to it the total expense of operation prior to the installation of this part of the plant which with the data given cannot be done, but it is safe to say we would get our current for almost nothing.

The following are accurate data pertaining to one isolated plant. It consists of three direct-connected units; one 35-kw., and two 125-kw., three-wire machines. The original cost was $17,000.

For the month of last November there was produced 36,635 kw.-hr. This generated at 0.025c. per kw.-hr. (central-station rate here) would be $915.875. There was 934,373 lb. of condensation from the heating system which at the central-station rate of 35c. per 1000 lb. would cost $327.03. This added to the charge for current would be $1242.90. The cost of operation was $728.56, not including taxes, which are taken care of in the interest charged. This deducted from the earnings, if the current and steam were sold at prevailing rates, leaves $514.34 profit for the plant. The foregoing figures are accurate, as all current is metered, coal and ashes weighed, water metered and the condensation is metered. All meters are read every six hours.

If this showing can be made in one plant there is no reason why it should not be done in others. The main thing for the engineers to do is to establish a form of

accurate records, get yearly data and have it ready for the central-station man when he comes.

P. J. HICKMAN.

Erie, Penn.

Mr. Lewis' facts are so few that it is difficult to make an intelligent analysis of his case. He does not state in what section of the country his building is located, but ordinarily the lighting load creeps up very rapidly in the winter months, beginning a little before four o'clock.

Evidently the building has the advantage of unobstructed light on four sides, and no inside offices, as the claim is made that the lights are used only for halls and elevator shafts until five o'clock in the evening.

He does not state whether, from lack of forethought or otherwise, the owners or designers of this building installed low-pressure boilers for heating purposes, as unfortunately is often the case, notwithstanding the fact that the cost of high-pressure boilers is only a trifle greater. Even estimating it was necessary to install new boilers to operate the proposed plant, he evidently has some very extraordinary conditions to overcome, to require an expenditure of $20,000.

It is reasonable to assume that two 75-kw. and one 25-kw. units would be ample to meet his requirements, particularly, as he states the maximum load would be of such short duration. The ordinary installation of a generator plant in a new building that would amply meet conditions, such as stated, should cost less than $10,000, which, even with such a very low power factor, would bring the fixed charges down to 2.4c. per kw.-hr.

HARRY J. MARKS.

New York City.

Self Instruction in Engineering Mathematics

In your editorial in the Feb. 18 issue on the above subject, the statement is made that it is only of late that books have been available from which a man of ordinary intelligence could learn the essentials of higher mathematics, particularly as it relates to engineering. A man who is past middle age and whose education has been neglected has quite an ordeal before him should he attempt to get an insight of the higher mathematics from most of the textbooks published on that subject nowadays. I have a good library of mathematical works, some of which were printed one hundred years ago. Also many which were published in 1911 and 1912 and from a comparison of the earlier with the later ones, I would state that the man who is striving to educate himself would learn more with less effort from those works published sixty years ago.

The names of modern writers on mathematics are legion, and 99 per cent. of their works is entirely worthless to the man who must instruct himself.

The writer, himself a burner of the midnight oil, would recommend the following works to those who are trying to better their condition: Eaton's "High School Arithmetic"; Loomis' "Algebra"; Ray's "Higher Algebra"; Bonnycastle's "Mensuration"; Loomis' "Trigonometry"; Blanchet's "Legendre"; Loomis' "Elements of Analytical Geometry"; Ball's "Applied Mechanics"; Olmsted's "Philosophy"; Olney's "General Geometry and Calculus."

The above with the valuable aid of POWER will advance any student far beyond his fondest expectations.

JAMES MCCLURE.

Fletcher, N. C.

Four-pass Boilers

I have been very much interested in the discussions in POWER in regard to the number of passes in horizontal water-tube boilers. It seems to me that in a discussion of this kind we should assume a broader scope to draw any value from our conclusions.

In the Feb. 25 issue of POWER one writer takes as an example a boiler operating at normal load and shows that with the gas temperatures obtained with a boiler so operated there is no saving by adding an extra pass.

The tendency now seems to be to force the boilers, i.e., run considerably over rating. Some of the best known stoker builders make a point of the overload capacity of their stokers. With boilers using forced draft and operated at from 150 to 250 per cent. of rating, the gas temperatures in the first pass would be from 1000 to 1200 deg. instead of 800 deg. as figured at rating, which would result in increasing stack temperatures above 500 deg.

In a case of this kind it would seem that the four-pass idea could be used possibly by decreasing the pass areas and giving the gases a longer travel over the cool tubes before reaching the stack. This would decrease the stack temperatures as well as increase the efficiency of the boiler by the greater heat transfer between the gases and steam due to the increased velocity of the gases. At just what point the gain to be realized will be offset by increased trouble, due to leaky baffles, would have to be determined by experience, but my opinion is that boiler companies will guarantee tight baffles at a considerably greater pressure of gases than is common in most boilers.

When it is known boilers are to be run over rating, a point which should not be overlooked in design is ample clearance space between the fire and lower row of tubes, as otherwise the gases, with their increased velocity, will reach the cold boiler tubes and become chilled before complete combustion takes place and the result will be an excess of black smoke coming from the chimney. I believe ample space between the tubes and fires is a much more effective way to obtain complete combustion than a scheme of horizontal baffling along the lower tubes, such as is shown in the Mar. 11 issue, page 328. The objection to the way of baffling is that besides causing pockets for dead gases over the lower baffle and under the upper baffle, it causes the gases to flow parallel to the tubes and is not as efficient as if the gases impinged on the tubes at right angles to them.

Such baffling, besides being very severe on the tile, as the writer points out, throws the gases toward the front header and subjects that to very severe conditions. If the boiler is so placed that sufficient space is not available for good combustion under the tubes it would be better to extend the front of the setting rather than try and get the Dutch-oven effect under the first pass. I do not wish to be understood as advocating a high overload on boilers, especially when economy of operation is a factor, but knowing that boilers are so operated, I am merely offering a suggestion as to how to increase their efficiency.

L. P. ST. CYR.

Dansville, N. Y.

INQUIRIES OF GENERAL INTEREST

Calking Butt Strap—If a butt strap on a boiler is leaking should it be calked on the outside or inside?

R. W. B.

All calking should be on the outside, because it will not spring the shell so much as the inside strap is much wider.

Lowering Receiver Pressure—How can the pressure in the receiver of a compound engine be lowered without lifting the relief valve?

E. M. W.

By lengthening the low-pressure cutoff, causing the low-pressure cylinder to take more steam.

Pump Delivery Against Different Pressures—Will a pump discharge the same quantity of water against a pressure of 100 lb. as it will against 10 lb. if the piston speed remains unchangd?

C. S.

The amount of water delivered is independent of the discharge pressure if the piston speed and slip are the same.

Engine Efficiency—What is the efficiency of an engine when its indicated horsepower is 563.74 and its brake horsepower 484.25?

E. S.

The mechanical efficiency of the engine is

$$\frac{484.25}{563.74} = 0.859 = 85.9 \text{ per cent.}$$

Absolute Condenser Pressure—When a vacuum gage on a condenser shows 27 in., what is the absolute pressure within the condenser?

S. E.

Assuming that the atmospheric pressure is 14.7 lb. per sq.in., the absolute pressure corresponding to a vacuum of 27 in. is

$$14.7 - (27 \times 0.49) = 1.47 \text{ lb.}$$

0.49 is the pressure corresponding to 1 in. of mercury.

Water Head for Atmospheric Pressure—What is the height of a column of water that would be supported by atmospheric pressure?

D. M.

It is usually given as 34 ft. Figured on the basis of 2.309 ft. being the height of a column of water corresponding to a pressure of 1 lb. per sq.in., the actual height of a column that would correspond to an atmospheric pressure of 14.7 lb. would be

$$2.309 \times 14.7 = 33.9423 \text{ ft.}$$

Too Short Cutoff—In a certain plant a 10-hp. motor was doing the work which a 35-hp. engine would not do. The trouble was that steam lap had been added so freely, and the eccentric advanced so much that the port opening was, for a very short period of time, cutting down the range of cutoff to a small fraction. How could the trouble be remedied?

J. N. A.

There are three remedies cutting off the steam lap and putting back the eccentric; getting an eccentric with greater throw, or putting on a rocker arm which will increase the valve travel giving a wider port opening.

Pump Delivery—What will be the discharge in gallons per minute of a pump having a 4-in. water cylinder and operating at an average piston speed of 60 ft. per min.?

M. D.

If the slip is neglected the delivery will equal the displacement of the piston or

$$\frac{4 \times 4 \times 0.7854 \times 60}{144} = 5.236 \text{ cu.ft.,}$$

which equals

$$5.236 \times 7.48 = 39.165 \text{ gal. per min.}$$

Pump Discharge Calculation—How much water will be delivered by a 14x8x12-in. pump making 1086 ten-inch strokes per hour?

M. N. S.

The water cylinder being 8 in. in diameter, its cross-sectional area would be

$$8 \times 8 \times 0.7854 = 50.265 \text{ sq.in.}$$

Neglecting the space occupied by the piston rod making a 10-in. stroke, the displacement per stroke would be

$$50.265 \times 10 = 502.65 \text{ cu.in.}$$

and neglecting slippage the discharge would be

$$\frac{502.65 \times 1086}{231} = 2363.1 \text{ gal. per hr.}$$

Injector Acting Against Different Pressures—Will an injector put water into two boilers that are under different steam pressures, as 90 and 120 lb. respectively, if the injector is supplied with steam from the boiler under the lower pressure?

E. S. C.

Injectors are made which, when supplied with exhaust steam of as low as 2, 3 or 4 lb. pressure, will feed boilers. Injectors may be made to feed boilers carrying 120 lb. pressure when the injector is supplied with steam at only 90 lb. pressure. Ordinarily injectors are constructed to operate when supplied with steam of the same pressure as that carried in the boiler which the injectors feed. The action of an injector is not dependent upon pressure except as that is translated into velocity, as explained in the answer to the inquiry "Exhaust-Steam Injector," on page 353 of the Mar. 11, 1913, issue.

Selecting a Dynamo—What kind and size dynamo would be suitable for lighting 250 sixteen-candlepower lanmps and driving a 10-hp. motor, 800 ft. distant?

A. O. K.

A 25-kw. compound-wound, 220-volt, direct-current generator would seem most suitable. Instead of 110 volts, 220 is recommended on account of the distance to the motor, as the higher the voltage the less the transmission loss for a given amount of energy. A capacity of 25 kw. should be ample for the load contemplated.

A 16-cp. carbon-filament lamp takes 55 watts, hence

$$250 \times 55 = 13{,}750 \text{ watts}$$

is the lighting load.

A horsepower equals 746 watts, hence

$$10 \times 746 = 7460 \text{ watts}$$

is the motor load, and the combined load

$$13{,}750 + 7460 = 21{,}210 \text{ watts or } 21.21 \text{ kw.}$$

A compound-wound machine is advised as giving better regulation than one shunt-wound.

Compressor Trouble—A wet gas compressor, used for cooling two ice boxes, gives the required temperature, 32 deg. F., but at intervals runs so cold that the packing leaks and the oil seems to freeze. Then suddenly the discharge pipe will warm up and the piston rod become hot. These sudden changes will continue all day. Closing down the expansion valve to get warmer gas to the compressor causes the suction gage to go down to 10 lb. Under present weather conditions (Mar. 25) the high-pressure gage will be as low as 90 lb. What is the trouble?

J. W. W.

Apparently the machine is operating at too great speed to do the required work at this time of the year. If the compressor is slowed down and the back pressure thereby increased to the proper amount, say 15 to 20 lb., the operation will be more regular.

Lately it has been found that these machines should be operated with a hot discharge, from about 180 to 250 deg. F., with a condenser pressure ranging from 90 to 185 lb.

Alternate freezing and thawing off of the suction pipe or hot or cold discharge may be due also to an insufficient amount of ammonia in the system.

A condenser pressure of 90 lb., if the liquid piping is properly proportioned, is an advantage as it saves power and consequently reduces the cost of operation. Some information on this subject is given on page 420, Mar. 25 issue, "Winter Work in Refrigerating Plant."

ENGINEERS' STUDY COURSE

Answers to Review Test Questions

(1) The number above the line (1680) is the numerator and that below the line (144) is the denominator.

(2) $\frac{22,043}{32} = 688\frac{27}{32}$.

(3) 34,840.

(4) No.

(5) $44\frac{3}{32} + 51\frac{6}{64} + 202 + 75\frac{1}{4} = 326\frac{13}{32}$.

(6) $242\frac{4}{16} - 229\frac{7}{16} = 12\frac{13}{16}$.

(7) $19 - 18\frac{3}{32} = \frac{29}{32}$.

(8) $19\frac{3}{4} \times 22\frac{5}{8} = \frac{79}{4} \times \frac{181}{8} = \frac{14299}{32} = 446\frac{27}{32}$.

(9) Dividing the numerator or multiplying the denominator divides the fraction.

(10) 9 in. equals 0.75 of a foot.

(11) 1 gal. = 3.785 liters.

(12) 1 mm. = 0.03937 in. or $\frac{1}{25}$ in. nearly.

(13) 13,500 B.t.u. × 0.252 = 3402 large calories.

(14) No; the volume of a barrel has never been definitely standardized.

(15) 212 deg. F. = 100 deg. C.

(16) The actual price is $16.20.

(17) 1760 lb. combustible.

(18) The ratio of heating to grate surface is 15.08 to 1.

(19) The inverse ratio of 20 : 4 is 4 : 20 = $\frac{1}{5}$.

(20) 400 : 220 = 3 : 1.65 hr. Delivering 400 gal. per min. the pump will fill the tank in 1.65 hr.

(21) $224\frac{3}{4}^2 = 50,512.5625$.

(22) $\sqrt{789} = 28.089$.

(23) From the formula the diameter should be 3.178 in.; the commercial size shaft to use is $3\frac{7}{16}$ in.

(24a) $33 \times 3 = 99 = \log 1.995635$.

(b) The log of 31,428 = 4.4973167.

(c) log 4.4980071 = 31,478.

(d) 31,444.73 = log 4.4975479.

(e) log 4.4931343 = 31,126.8.

(f) $642^{\frac{1}{3}} = 286.15$.

(26) There are 270 deg. in ¾ of a circle.

(27) Side = $\sqrt{\frac{21.217}{0.433}} = 7$ in.

(28) The plane is 1882.43+ ft. long.

(29) 26.928 gal. will be needed.

(31) $V = \frac{1}{3} h (B + b + \sqrt{B \times b})$.

(30) Average circumference.

In the first line of example (32) of the Apr. 8 issue a typographical error appeared. The value of a long ton was given as 2140 lb. instead of 2240 lb.

(32) The coal pile will weigh approximately 1356.032 tons.

(33) $11^3 \times 0.5236 \times 0.26 = 181.197$ lb.

Lessons to Come

Most steam plants do their work by virtue of the heat contained in coal. The combustion of coal is, therefore, an important subject and one which every engineer and fireman should understand. This subject will be made clear and, we believe, interesting in the series of lessons to begin in the next issue.

Instructions will be given for making much of the apparatus used for getting samples of coal and for making coal and flue-gas analyses.

These lessons will be of value to firemen as they explain how to save coal. This, firemen are glad to do if they know how. The more they save the less they have to shovel and the less are the coal bills.

If there are any points that were not clear in the Mathematics Course we will be glad to have our readers write us of their difficulties and we will answer them by letter, and where the questions warrant it, will print them and their answers in the department "Inquiries of General Interest."

Federal Help for Oregon Power Projects

A contract between the United States Government and the State of Oregon was approved by the Secretary of the Interior, Franklin K. Lane, on Mar. 27, whereby the secretary agrees to withdraw sufficient land and the Oregon state engineer hold the necessary water for the projects under investigation. A project may be released to private interests providing they pay the cost of preparing plans, if the development is in harmony with the public plans for the best uses of the Oregon waters.

There is now available $100,000, one-half of which each party is to pay. This sum will be spent mainly on the investigation of the Deschutes River project, embracing 300,000 acres. The start will be made on the Tumalo Creek unit of 35,000 acres, for which Oregon has made a construction appropriation of $450,000. Secretary Lane will allow an equal amount for the entire project.

When completed the Deschutes undertaking will have cost about $8,000,000. If Oregon will raise $4,000,000 toward the construction of this project, Secretary Lane believes that an equal amount could be drawn from the reclamation appropriation for this work.

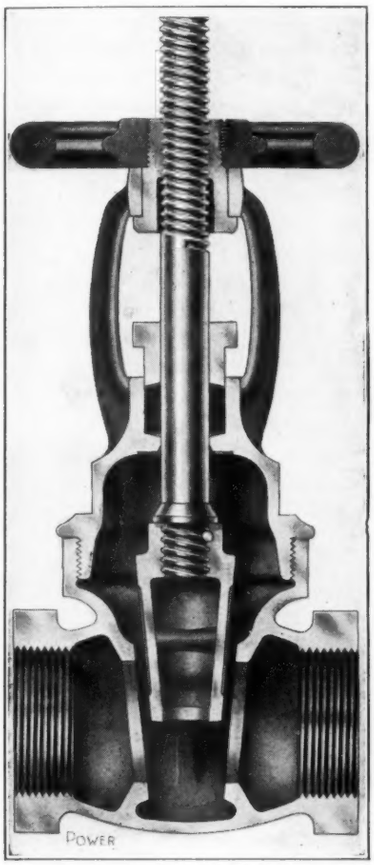
Jenkins Brass Gate Valve

In the valve, illustrated herewith, a yoke and traveling spindle are used. As the spindle threads are exposed they are easily lubricated, materially increasing their durability, particularly when the valve is used in dry- or superheated-steam lines. The traveling spindle is raised or lowered through the handwheel as the valve is opened or closed.

The valve has a solid, double-faced metal wedge or gate, guided by ribs cast on the inside of the body, which fit in corresponding channels in the wedge, thereby preventing the wedge from dragging across the seat. The rib on one side of the body is of a different thickness from that on the opposite side, and as each channel in the wedge fits its corresponding rib, it is impossible to reverse

the wedge in the valve. All parts are interchangeable.

The body is globe shaped, a design which gives a neat appearance, and full opening. The valves are made in three distinct patterns: standard, for 125 lb. steam pressure, or 175 lb. water pressure; medium, for 175 lb. steam, or 250 lb. water, and extra heavy, for 250 lb.



NEW JENKINS BRASS GATE VALVE

steam, or 400 lb. water. This valve is made screwed or flanged in either straightway or angle type, with unions for radiator work, and with hose ends, the hose valves conforming with the underwriters' specifications. It is made in all sizes from ¾ to 3 in. inclusive, by Jenkins Bros., 80 White St., New York City.

⁂

The Bureau of Mines announces the following new publications: Bulletin 63, "Sampling Coal Deliveries, and Types of Government Specifications for the Purchase of Coal," by G. S. Pope; it describes in detail methods of sampling and reasons therefore and cites new specifications for purchase of coal by the Government. Technical Paper 31, "Apparatus for the Exact Analysis of Flue Gas," by G. A. Burrell and F. M. Seibert. The Bureau of Mines has copies of these publications for free distribution. Order them by number and title, addressing the Director of the Bureau of Mines, Washington, D. C.

We have just received the bound volume of the 1912 "Proceedings" of the American Electric Railway Engineering Association. It is got up in the same attractive form as former volumes and, besides the matter pertaining purely to electric-railway affairs, it contains the report of the committee on power generation. This report gives in detail the practice of several large electric companies, as regards the purchase, specifications and testing of coal and lubricating oils, also the analysis and treatment of boiler-feed waters.

The "Proceedings" are published from the office of the secretary of the association at 29 West Thirty-ninth St., New York.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

"The reassuring notes of factory whistles will relieve the distraught minds of those who are still nerve-racked and ill." This is an optimistic note from Dayton, Ohio, that should ring louder and louder. There is not much room for sorrows while we are working, and it's just as well to forget them when we can.

⁂

What do you know about this? The Steel Corporation has refused to operate its mills on Sundays. There's no use in having a reputation as a wicked trust, and then refusing to live up to it. Of course, a power-plant engineer can, and usually has to, work on Sunday, but who are we, anyhow?

⁂

Ever since you and I were knee-high to grasshoppers, we've had dinged in our ears: "Get out of the rut! Don't dig a rut for yourself!" Now, along comes a writer on industrial economics who says: "The real secret of success is in establishing ruts of a useful kind; ruts with switches that may be operated by the mind at will." Soon we'll have to pay ten dollars a pair for second-hand, well-worn ruts that once could not be auctioned off at a rummage sale at five cents a bunch. Where do we get off, anyhow?

⁂

The Standard Oil Co. has agreed to pay wages for life to Vincent Pelican, Constable Hook, N. J., "who was injured in the company's employ," wherever that is. The intention is good, and as this growing little concern appears to be getting along right smart, we hope it will manage to scrape up enough to carry out this laudable undertaking.

⁂

If you were asked to give your definition of a gentleman, we bet one of those new nickels that looks like a button on little Lizzie's winter coat that you can't do better than this:

"A man that's clean inside and out; who neither looks up to the rich nor down to the poor; who can lose without squealing and who can win without bragging; who is considerate of women, children and old people; who is too brave to lie, too generous to cheat, and who takes his share of the world and lets other people have theirs."

And this standard works out as well for the overalls as for the joyous habiliments of swell society.

⁂

A TALE OF A TAIL

By Billy Spills

This is a tale of a horse's tail electrically waved from Australia, but not exactly verbatim.

'Twas a dark and stormy night on the plains, and Antonio was madly galloping on his fiery steed, or rather, the horse was galloping and Toni was doing the mad end of it. A blinding flash, and directly in the path of the travelers a giant oak was struck by lightning blim! blam! just like those. The dispatch says "the tree was split in halves"—you know, two halfs. And right here hangs the tale of a tail which, shortly, will hang no longer.

Was Bucephalus (Australian for "horse") intimidated by the two halves of this acorn hatchery that yawned and gaped before him—before even him and Toni could yawn or gape? Nein! Non! Nem! Nej! Niet and just plain No! [The "no" in six languages is to display the author's education.—Ed.]

What did 'Cephy did? He showed his rearing by rearing, and then bounded through the gaping gap, right between the two halves—all but his tail To the west he madly made, but eastwardly there was trouble in the Balkans, in a manner of speaking. Them two halves suddenly became as one whole one—and shut up! The tail was clutched in the oak's crool embrace even as clutches the octopus with his ten tackles (number uncertain.) The tail was severed at the roots—the tail's roots, not the tree's roots, you understand.

This is the end of the tail tale, really. For aught we know, the horse is running yet—like one of those sure things in the second race—but "the tail can still be seen protruding from the tree." By this time the sturdy oak may have been lutherburbanked into a horse-chestnut tree.

Toni? That we should worry! But as it was the end of the tail that began this tale, at the tail end it is only fair to add that "the young man received a severe shaking, but otherwise came through the ordeal safely."

Steam Consumption of 4-Valve Engines

SYNOPSIS—For engines of different makes, differences in the water rate of 10 lb. per i.hp.-hr. are readily possible, and even for the same make of engine the rate may vary several pounds.

Engines of similar type, built by different manufacturers, are sometimes erroneously assumed to have about the same steam-consumption requirements. This impression is probably gained from the fact that similar types of other machines of various builders, for instance, electric generators, have about the same efficiencies. To show that there is a considerable difference in steam consumption between engines of the same type but of different make, and even engines of the same make, the Harrisburg Foundry & Machine Works recently submitted the data presented herewith. The accompanying table gives the results of a series of tests conducted by a number of prominent mechanical engineers on nonreleasing

TEST DATA ON FOUR-VALVE ENGINES

Test No.	Date	Mech. Engineer	Cyl. Dia., in.	Stroke, in.	Speed R.p.m.	Speed Ft. per Min.	Initial Pressure, Lb. Abs.	Quality	Steam Rate, Lb. per I.Hp.-hr. ¼ Load	½ Load	¾ Load	Full Load	1¼ Load	Minimum B.t.u. per I. Hp.-hr.	Maximum Efficiency Rankine	Maximum Efficiency Thermal
1	4-16-1905	H. W. Spangler R. G. Carpenter	16	16	210	560	140	Dry Sat.	30.37	23.89	22.24	22.74	23.61	3637	70	11.30
2	6-28-1905	H. Diederichs	19	19	205	649	135	Dry Sat.	.....	23.9	22.46	22.27	.....	3584	71	11.29
3	9-20-1911	C. F. Sponsler	15½	16	210	560	140	Dry Sat.	26.9	22.2	21.7	22.0	23.0	3549	71.7	11.58
4	10-18-1911	H. M. Price	14	15	250	625	125	Dry Sat.	26.55	21.5	21.15	21.06	21.62	3274	77.7	11.96
5	8- 0-1912	M. C. Hartman	14½	16	225	600	155	Dry Sat.	26.34	20.8	19.8	20.46	21.6	3384	75.2	12.67
6	12- 0-1912	H. M. Price	17	18	220	660	125	Dry Sat.	24.7	21.25	20.9	21.17	22.9	3249	78.3	12.05
7	12- 0-1912	H. M. Price	14	16	250	666	125	Dry Sat.	25.18	21.5	21.25	21.27	22.23	3303	77	11.85

Corliss valve-gear engines made by this company. The exhaust was into the atmosphere in each case.

Test No. 1 in the table, conducted by the late Prof. H. W. Spangler, of the University of Pennsylvania, established a record at the time. This test was soon followed by another conducted by Profs. R. C. Carpenter and H. Diederichs, of Cornell University. The results agree closely with the former test and tend to substantiate its accuracy.

In test No. 3, conducted by C. F. Sponsler, chief engineer of the Bureau of Standards of the United States Government, the operating conditions were the same. It may be noticed that the results were bettered at each point of the load and that the curve of steam consumption was flattened to a considerable extent; that is, the steam consumption at one-fourth load more nearly approaches that of full load. This would give a high average efficiency under varying conditions of load.

In test No. 4, H. M. Price, mechanical engineer of the Treasury Department of the Government, secured some still lower results, partly due to the higher speed. These results were bettered on a slightly larger engine by M. C. Hartman, consulting engineer for the Webster Safe & Deposit Co. of Chicago. A steam consumption of 19.8 lb. per i.hp.-hr. was obtained. This is slightly lower than the full load rate of 20.46. In this test, the steam pressure was 155 lb. abs. as compared with 125 lb. abs. in test No. 4.

In tests Nos. 6 and 7, both conducted by H. M. Price, the minimum steam consumption is not as low as obtained in test No. 5. The curves of steam consumption for different loads, however, are flatter. In the larger engine there is a difference of only 1.8 lb. in the steam consumption per indicated horsepower-hour between one-fourth load and 25 per cent. overload. In the smaller engine the difference is 2.95. Between the limits given, the economy would, therefore, be very nearly uniform under varying load conditions, and at the higher pressures of previous tests would surpass earlier attainments.

To illustrate the variation in steam consumption between engines of different make, a number of guarantees from Government bids are submitted. It will be recognized that in Government negotiations the fulfillment of guarantees is a vital part of the contract and failure to meet them results either in the rejection of the machine or an acceptance with a heavy penalty imposed. This, of course, would tend to make the guarantees of steam consumption conservative, but as bids are usually compared on an evaluation of steam-consumption guarantees, an incentive is offered the bidder to cut down his guarantee to the lowest limit and still come within the possibilities of his engine. Under these circumstances, a comparison of guarantees submitted will tend to show the capabilities of the engines.

Among bids offered the Bureau of Standards were two proposals on a nonreleasing Corliss valve engine of 190 hp. capacity with an initial pressure of 140 lb. abs. and atmospheric exhaust. The guarantees are appended as Bidder A and Bidder B, the quantities being pounds of dry steam per indicated horsepower-hour.

Loads	¼	½	¾	Full	1¼
Bidder A	33.2	26.1	25.0	25.6	27.6
Bidder B	32.0	24.0	22.5	23.0	23.8

On Mar. 15, 1912, bids were received by the Treasury Department on a 160-hp. engine to operate between 125 lb. abs. and atmosphere, having guarantees as follows in pounds of dry steam per indicated horsepower-hour:

Loads	¼	½	¾	Full	1¼
Bidder A	31.0	25.0	23.2	23.5	24.0
Bidder B	....	30.5	25.5	23.5	25.5
Bidder C	27.5	22.5	21.4	21.75	22.5

On May 6, proposals for a 100-kw. engine to the Treasury Department brought out the following guarantees, the quantities being in pounds of dry steam per kilowatt-hour. An initial pressure of 125 lb. abs. and atmospheric exhaust were stipulated. All bidders offered the same generator, so that the data really compare the engines:

Loads	¼	½	¾	Full	1¼
Bidder A	75.6	47.8	42.9	41.9	43.4
Bidder B	60.6	41.9	37.9	37.1	38.3
Bidder C	56.8	37.8	34.0	33.7	34.7

On Nov. 25, 1912, the Treasury Department opened bids for 100- and 200-kw. units to operate on an initial pressure of 165 lb. abs. and against atmospheric pressure. The following guarantees were offered for the larger machines, the quantities being given as before in pounds of dry steam per kilowatt-hour:

Loads	¼	½	¾	Full	1¼
Bidder A	56.2	40.4	37.0	37.45	39.4
Bidder B	54.0	39.0	33.5	33.5	35.1
Bidder C	68.2	42.8	37.6	37.8	40.8
Bidder D	52.3	38.0	34.1	33.3	34.3
Bidder E	58.3	37.1	33.3	32.8	33.9

The guarantees submitted on the 100-kw. units were as follows:

Loads	¼	½	¾	Full	1¼
Bidder A	62.0	44.0	39.9	39.7	41.4
Bidder B	60.0	42.0	36.0	36.0	37.5
Bidder C	72.0	45.0	38.6	38.7	42.0
Bidder D	52.7	38.5	34.7	34.0	34.9
Bidder E	59.6	37.3	33.5	33.2	34.2

It is thus apparent that the range in steam consumption is considerable, and to show what this difference in the steam rate really means, an analysis of one of the cases cited will be made. Take the engines offered the Bureau of Standards as an example. The price submitted by Bidder B was about $250 higher than that offered by Bidder A. Assume the engine to run ten hours a day, 300 days a year, operating at one-half load 25 per cent. of the time, three-quarter load 50 per cent. and full load 25 per cent. of the time. Assume the cost of coal to be $3.50 a ton of 2000 lb. and that a rate of evaporation of 7 lb. of water per pound of coal is obtained. The following tabulated results show the saving which would be effected by the more economical engine:

Loads	¼	¾	Full
Bidder A's guarantee	26.1	25.0	25.6
Bidder B's guarantee	24.0	22.5	23.0
Difference, steam per i.hp.-hr	2.1	2.5	2.6
Time factor, per cent	25	50	25
Saving steam per i.hp.-hr., lb	0.525	1.25	0.65
Indicated horsepower	100	150	200
Saving steam per hour	52.5	187.5	130

Total saving steam per hour, lb	52.5+187.5+130=370
Total saving steam per day, lb	370×10=3700
Total saving steam per year, lb	3700×300=1,110,000
Total saving coal per year, lb. (about)	1,110,000÷7=160,000
Total saving coal per year, tons	160,000÷2000=80
Total saving money per year	80×$3.50=$280

Operating under the assumed conditions, it is evident that the saving from the more economical engine would amount to $280 per year, provided the heating demands were not greater than the supply of exhaust steam with the engine operating at maximum economy. This would return to the investor 112 per cent. per year of the difference in price between the two engines. If the heating demands were in excess of the exhaust steam, the saving would be reduced. For at least six months of the year this excess demand would not obtain and the saving for this period would be 50 per cent. of the yearly amount.

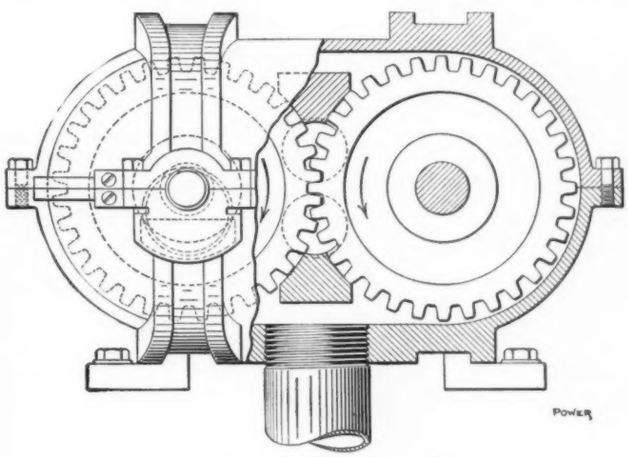
For approximately 60 per cent. of the heating period, the requirements would exceed the amount of steam exhausted and no saving over the less economical engine would be effected. The saving for this period would then be only 40 per cent. of half the total amount, or 20 per cent. of the total amount. The net yearly saving would then be 50 per cent. for the summer months and 20 per cent. for the winter months, or 70 per cent. of the total estimated amount of $280, which would be $196. This would yield 78.4 per cent. on the investment of the additional $250.

In the above calculations, the saving shown is in coal alone, and no consideration is given to the cost of the additional water, ash removal, etc., required for the less economical engine. These items would more than counterbalance any added interest charges on the initial cost.

In addition to steam economy, a more efficient engine will tend to give better operating results, and the cost of maintenance, due to the superior design, materials and workmanship which are usually responsible for a lower steam consumption, should be less. This would indicate that the strife for economy is well worth while, and that the engine with the lowest steam-consumption guarantee is the one to purchase, provided the guarantees made are bona fide and can be readily obtained in practice. In lieu of the requirement of an acceptance test with understood penalties for failure to meet the guarantees offered, it might be well to call for certified test data of similar engines operating under the same conditions. This data would at once show the possibilities of the particular make of engine to which it referred and would tend to prevent the selection of an inefficient engine, the loss from the use of which could not be offset by the penalty exacted.

The Clark Gear Engine

A new type of engine of simple construction has been designed by Charles H. Clark, of New York City. In its simplest form it consists of two intermeshing gears and two tapering blocks having curved faces close to, but not touching the teeth. One block is located above and the other below the intermeshing point, as indicated in the accompanying drawing. The blocks cover only small arcs of the gears and the larger parts of the gears are



HALF SECTION THROUGH ENGINE

free to revolve in the casing. End plates between the blocks inclose the working section.

Depending upon which direction it is desired to run the engine, steam is admitted above or below the center line of the gears and pushing against the teeth at full pressure causes rotation. As the teeth pass the apex of the block small volumes of steam are inclosed and carried as far as its base, where exhaust to the casing and then to atmosphere takes places.

It is the wedge-shaped blocks which distinguish the present design from other types of rotary engine. Unbalanced pressure, due to high steam pressure over a large area of the gears and exhaust pressure on the other side, has been the bugbear of inventors. It must be borne by the shaft and tends to cause excessive friction and wear. In the Clark engine the small area exposed to unbalanced initial pressure of the steam practically eliminates this trouble.

In the single-stage unit it is evident that the expansion of the steam is not utilized. To get the benefit of expansion it is planned to compound the engine, using

several pairs of gears and exhausting from one to the other, the working volume increasing with a corresponding drop in pressure in each stage. As the number of stages increase, the economy is bettered. Basing his conclusions on results obtained from the simple engine, Prof. H. L. Parr, of Columbia University, estimates that a four-stage machine working between 100 lb. and atmosphere may be expected to develop a brake horsepower-hour on 30 lb. of steam.

A single-stage engine, rated at 35 b.hp. and in test developing 50, has been built and has been subjected to a number of tests, some at Columbia University and others at the New York Central power house in Yonkers. The best water rate obtained was 44 lb. per b.hp.-hr., when developing 46 b.hp. with an admission pressure of 97.5 lb. gage. With lower pressure the rate increased and at 10 lb. gage 94.2 lb. of steam per brake horsepower-hour were used. For intermediate pressures the rates varied between these limits. The floor space occupied by the engine was 2 ft. 11 in. by 2 ft. 1½ in., which equals 6.2 sq.ft., or 0.18 sq.ft. per horsepower of rating. The total weight of the engine was 620 lb. complete.

Size, Capacity and Power Required for Centrifugal Fans

In the article under the above title, in the issue of Jan. 21, 1913, an error was inadvertently made in the redrawing of the diagrams which formed pages 74 and 75 of the article.

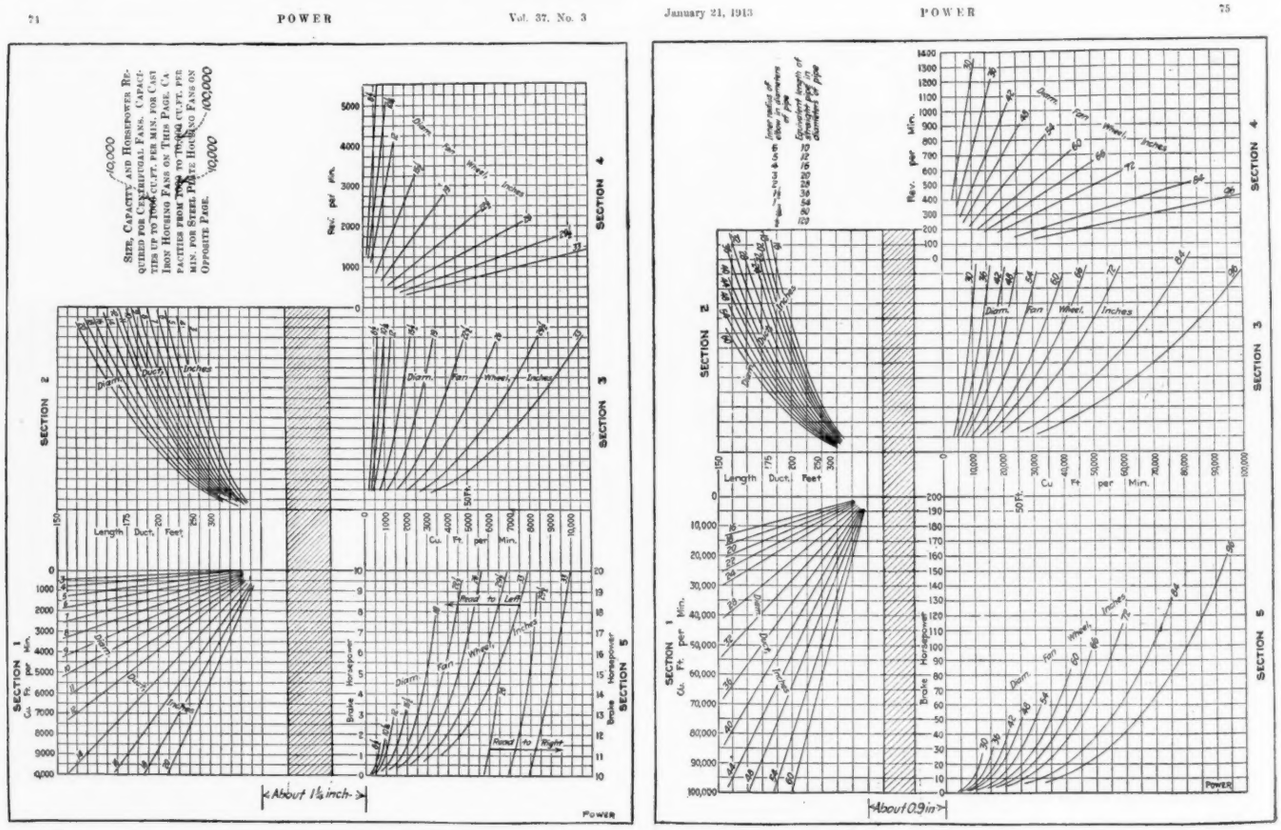
Evidently the draftsman, with an eye to space economy, thought there was an unnecessary distance between the left- and right-hand halves of the diagrams on the two pages and so reduced the distance between sections 2 and 3, and between 1 and 5 on page 74. This space should actually be about 1¼ in. instead of about ¾ in. In the same way the distance on page 75 between sections 2 and 3 and between sections 1 and 5 was reduced. This distance should be about 0.9 in.

The readings for ducts 100 ft. long would be correct with the diagrams as they were printed, but where the process indicated by Fig. 2 in the article is carried out, for ducts 50 ft. long, the readings would be inaccurate. If these curves are used by any of our readers it will be well for them to cut the diagrams out, separate them and paste them together again the proper distance apart as indicated on the diagrams herewith.

Permutite, a Water-Softener

A new process for softening water has been introduced in Germany by Riedel & Cie Actien Gesellschaft, Berlin.

In a filter apparatus about 3 ft. in diameter and 10 ft. in height is placed about two tons of a material, named "Permutite" by its inventor, Professor Gans, of Berlin. It is a silicate of aluminum and sodium and is obtained by smelting together clay, soda, silica and one or two minor substances. The result is an artificial zeolithe, that is, a silica of soda in which the sodium may be re-



CORRECTION TO DIAGRAMS FOR "SIZE, CAPACITY AND POWER REQUIRED BY CENTRIFUGAL FANS" AS PRINTED IN THE JAN. 21 ISSUE. SHADED AREAS SHOW WHERE THE DIAGRAMS SHOULD BE EXTENDED HORIZONTALLY

placed by calcium, magnesia or manganese, if solutions of these metals are filtered through a bed of the substance. If a solution of calcium carbonate, for instance,

is filtered through the permutite, the latter retains the calcium and the water leaving the apparatus contains sodium instead.

An apparatus such as referred to is capable of softening 5500 gal. of water, showing a hardness of 18 deg., within an hour, or 66,000 gal. in 12 hr. After this time, it should be rested or rather regenerated. The process of regeneration consists in passing through the permutite a salt (NaCl) solution containing from six to eight times as much sodium as there was calcium and magnesium retained by the filter while softening the water. Once a month, however, twice that quantity of salt should be used to effect positive elimination of all calcium and magnesium salts.

Permutite has a shiny appearance, similar to mother of pearl, and is made in grains varying from 12 to 50 mesh, so that the surface, which determines the efficacy of the material, is relatively great. As, in the manufacture of the material, the soluble silicates are removed by treatment with hot water before the permutite is put into the apparatus, practically no loss of weight is encountered during service. A test made in a German factory showed a loss of weight of 5 per cent., or 198 lb., after one year of use.

Large National Heater

One of the largest, if not the largest, hot-water heaters ever built is herewith illustrated. It is of the U-bend type, Fig. 1, and has a capacity of 125,000 lb. of water per hour, heating it from 100 to 212 deg. F. with exhaust steam. It sets horizontally on cradles and is almost 9 ft. long, 5½ ft. in diameter, and contains two hundred and twelve 1¼-in. brass tubes expanded into a header.

Water enters at the front through an 8-in. inlet and

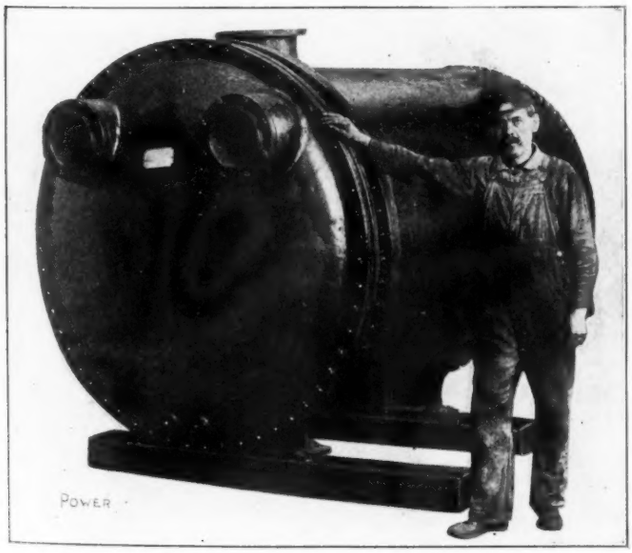


FIG. 1. LARGE NATIONAL HEATER

flows through a bank of tubes, passing longitudinally from front to rear, then to the front again, and again to the rear, making four passes before leaving through a water outlet of the same size, also at the front, Fig. 2. The water is compelled to travel through the tubes, as stated by baffles on the header. These baffles divide the space horizontally into two main sections, and other baffles divide the upper section into three parts and the lower section into two parts, as shown.

Steam enters a 10-in. inlet at the top and entirely surrounds the tubes, the condensate leaves the heater by a 4-in. drain at the bottom. All tubes are of brass. The steel-plate shell, does not corrode because it is not in contact with the water.

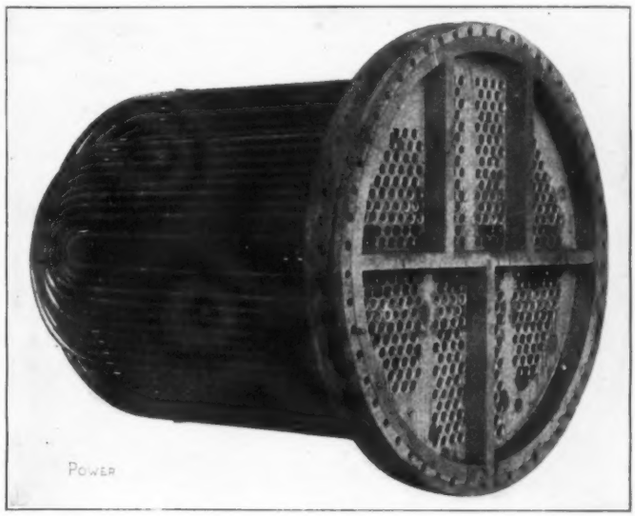


FIG. 2. PIPE COILS AND HEADER REMOVED

The heater can be used as a storage heater by reversing the action, that is—directing the steam through the tubes which are then surrounded with water.

This heater is made by the National Pipe Bending Co., New Haven, Conn.

Turners Falls Hydro-Electric Development

Extensive developments are being planned by the Turners Falls Co., Turners Falls, Mass., near its present generating station on the Connecticut River, states the *Engineering Record*. The present station is rated at 7000 hp. and receives its waters through a canal which is diverted from the river above the town. This canal is to be extended more than two miles to Montague City, where a fall of 60 ft. will be obtained. A new dam, now in course of construction, will provide sufficient storage for the generation of 40,000 hp. during eight months of the year. The power developed at Turners Falls is sold to a number of allied companies which act as distributers.

A high-tension line from the station at Turners Falls is at present being built through Greenfield, Amherst and Chicopee, with a branch to East Hampton. The main line will probably later be extended across the Connecticut River through West Springfield. A substation is being built at Chicopee and the local distribution in the town and vicinity will be at 13,200 volts. The company is also building a substation at Amherst, which will be a sectionalizing station in the transmission line and will also contain transformers for local distribution by the Amherst Gas Co.

The power plant at Turners Falls will have a reserve in the steam plant of the Greenfield Electric Light Co. at Greenfield and one of the East Hampton Gas Co. at

Mount Tom. A 66,000-volt branch circuit will connect the Amherst substation with the Mount Tom steam station. The transmission line is complete as far as Amherst and will be finished to West Springfield in June. The Chicopee substation will be ready for operation about July 1.

Canadian Inspection of Boiler Construction

Boiler inspection standards and regulations will be uniform throughout the Canadian provinces, after July 1, as a result of negotiation between representatives from the different provinces, states "Engineering News." These regulations provide for the rigid inspection of all boilers during construction to see that proper materials and safe methods are employed. The object in making the regulations uniform is to insure a uniform degree of safety and to enable a certificate, granted in respect to a boiler in one province, to be accepted in any of the others.

To carry out the provisions of the act the province will be divided into districts with a chief inspector and two or three district inspectors. These inspectors will be given ample discretionary power in their work, with authority to insist on a proper standard of efficiency being maintained.

Hitherto there has been no such system of inspection. Steamboat and railway boilers are not included, as these are dealt with in a separate act. Once a boiler is inspected and installed it passes under the jurisdiction of the inspectors under the factories act. But where an old boiler is resold that has not been examined within one year of the time of sale, it may not be moved and applied to new work without a further inspection.

Directory of Commercial Organizations

In response to a Senate resolution passed in December, the Department of Commerce has submitted to the Senate a list of the commercial organizations in the United States. This record, with a list of agricultural organizations, will be printed for distribution, provision being made for 1500 copies for the use of the Senate.

The list of commercial organizations was prepared by the Bureau of Foreign and Domestic Commerce, which for nearly two years has been collecting for use in its own work detailed information regarding such organizations, their functions, membership, income, etc. The information in the files of the bureau at the time the resolution was adopted was supplemented by such additional facts as it was possible to obtain before Feb. 15, the date on which the list was to be submitted to the Senate, and this list when published will record about 3500 national, interstate, state and local organizations.

In the compilation of its information the bureau has utilized various symbols to indicate the field of service and the activities of the various organizations. These symbols have been used in the list submitted, so that when published it will furnish a complete record of the organizations. The information thus compiled constitutes a directory of commercial organizations of the country such as has never before been prepared and it should prove of practical value to business men.

In addition to the 1500 copies for the use of the Senate, the list will be issued as a bulletin of the Bureau of Foreign and Domestic Commerce (Miscellaneous Series No. 8). Copies of this bulletin will be sold for 15c. a copy by the Superintendent of Documents, Government Printing Office, Washington, D. C.

Allis-Chalmers Manufacturing Co.

Directors of the Allis-Chalmers Manufacturing Co., formed to succeed the Allis-Chalmers Co., met in New York on Mar. 17, and completed their organization by electing officers. John H. McClement, of New York, was made chairman of the board of directors, and Otto H. Falk, of Milwaukee, president of the company.

The executive committee chosen was Frederick Vogel, Jr., president of the First National Bank of Milwaukee; Gustave Pabst, chairman of the Pabst Brewing Co.; J. D. Mortimer, president of the Milwaukee Heat, Light & Traction Co.; Oliver C. Fuller, head of the Wisconsin Trust Co., of Milwaukee, and Messrs. McClement and Falk. The other directors are Max Pam and F. O. Wetmore, of Chicago, Arthur W. Butler, Charles W. Cox, Oscar L. Gubelman, R. G. Hutchins, Jr., Arthur Coppell, and William C. Potter, of New York, and James P. Winchester, of Wilmington.

A call is issued for the rest of the amount due on assessments as follows: On preferred stock $4 payable on Apr. 24, and $4 on May 15, 1913; on common stock, $2 on Apr. 24 and $2 on May 15, 1913. It is stated that the lines of manufacture which were produced by the old Allis-Chalmers Co. will be continued. The new company is capitalized at $42,500,000, and is said to have a substantial working capital through assessments on stock.

Engineering Students Make Annual Inspection Trip

The annual inspection trip of the senior mechanical engineering students of the Sheffield Scientific School, Yale University, began on Mar. 12 and lasted eight days. Visits were made to Holyoke, Schenectady, New York City, Hoboken, Harrison, N. J., Philadelphia and South Bethlehem, Penn.

At Holyoke the students inspected the water-power system and plant of the Crocker-McElwain Co., manufacturers of paper. Two days were spent at Schenectady, the first devoted to the General Electric Co.'s plant, the second to that of the American Locomotive Works. At the General Electric plant the students were the guests of the company at a luncheon given in their honor. The evening of the same day was pleasantly spent at a dinner in the Golf Club quarters at which the Yale alumni feasted the undergraduates.

In New York City the students were guests of the New York Edison Co., which took them about the city in sightseeing buses and treated them to a sumptuous luncheon at one of its substations. The Waterside stations were opened to the students for inspection, as were the Interborough station on Fifty-ninth St. and the new Grand Central Station.

The next few days were spent at the Keuffel & Esser Co.'s plant in Hoboken, the Henry R. Worthington Harrison plant, the Lardner's Point pumping station at Wissoning, Penn., the establishment of the Curtis Publishing Co., and the Cramp Co. shipyard in Philadelphia.

The big thing of the trip was a visit on the last day to the South Bethlehem plant of the Bethlehem Steel Co., where the students were shown through the plant, tracing its products from the ore to the finished piece.

Charters for 54 Electric Firms

Fifty-four electric companies in Allegheny, Westmoreland, Washington and Greene counties were chartered at Harrisburg, Penn., on Mar. 27, each with $5000 capital.

Thirty-one of the companies are incorporated by Arthur P. Dampman, H. W. Kalberer and W. E. Miller of Pittsburgh; seven companies by A. E. Dubois, Byron Trimble and C. W. Shock of Pittsburgh; 14 companies by G. F. Godshall, Henry Wharton and Spencer Ervin of Philadelphia, and one by W. B. Skelly, John W. Newmyer and A. F. Ramsey of Irwin.

Blowoff Pipe Pulls Out

On Mar. 19, two men were badly scalded in the boiler room of the Montrose Hotel, Cedar Rapids, Iowa. There are two 125-hp. return-tubular boilers in the plant, but only one of them was in operation and was carrying a pressure of about 90 lb. Suddenly the horizontal run of the 4-in. blowoff pipe pulled out of the elbow in the combustion chamber. The force of the steam and water blew open the firebox doors and scalded the fireman. Another man was working on the idle boiler and to get to the door had to pass through the escaping steam. He was also badly scalded, but both men will recover.

The pipe was not protected and had probably deteriorated, through the action of the gases, to such an extent that it could not withstand the working pressure. Another point worthy of notice is that if two doors had been provided in the boiler room, only one man would have been scalded.

Water power for cotton mills, to the extent of about 100,000 hp., has been developed in Georgia and the Carolinas, according to a report of the United States Geological Survey. Public service corporations in these three states are developing from 300,000 to 400,000 hp.

NEW PUBLICATIONS

DIE BERECHNUNG ROTIERENDER SCHEIBEN UND RINGE. NACH EINEM NEUEN VERFAHREN. By Max Donath. Julius Springer, Berlin. Pages 16; 6¾x9½ in.; paper; 5 illustrations and large folded chart. Price 1 mark.

In designing steam turbines, turbine pumps and all other machines of high rotative speeds, great care has to be taken in determining the inner strains of all revolving parts. The present method used necessitates an extensive knowledge of higher mathematics and has the disadvantage of taking considerable time.

In this little pamphlet the author develops what he claims is an entirely new method of calculating the proportions of such parts as disks and rings. He has simplified it enough for anyone possessing some knowledge of elementary algebra to be in position to do the work in relatively short time.

In the five chapters comprising the booklet, the author starts with the development of his new method and continues to show how, by means of his formulas and chart, disks of even thickness and disks of uniform strength radially can be easily designed.

Practical examples explain the method of finding general profiles of revolving disks as especially adapted for steam turbines. The whole is written in simple language and can be understood by any man with mechanical ability and a knowledge of German. This pamphlet should be useful to designers of steam turbines, turbine pumps, turbo blowers, etc.

BOOKS RECEIVED

COST REPORTS FOR EXECUTIVES. By Benjamin A. Franklin. The Engineering Magazine Co., New York. Cloth; 149 pages, 5½x8½ in.; plates; indexed. Price $5.

PRACTICAL MATHEMATICS FOR TECHNICAL STUDENTS. By Edward L. Bates and Frederick Charlesworth. D. Van Nostrand Co., New York. Cloth; 513 pages, 4¾x7½ in.; 325 illustrations; tables; indexed. Price $1.50.

PRACTICAL GEOMETRY AND GRAPHICS FOR TECHNICAL STUDENTS. By Edward L. Bates and Frederick Charlesworth. D. Van Nostrand Co., New York. Cloth; 621 pages, 4¾x7½ in.; 566 illustrations; tables; indexed. Price $2.

SOCIETY NOTES

The New England Society of Superintending Engineers held its regular monthly meeting and dinner at the American House, Boston, Mass., on the evening of Mar. 29. A number of prominent engineers were elected to membership. The business of the evening was taken up mostly in the framing of by-laws. It is the intention of the society at all future meetings to have papers on engineering topics read and discussed. President George W. Walsh presided.

On the evening of Apr. 2, the fourth annual banquet of the Northampton No. 3 Association, N. A. S. E., was given at the Draper Hotel, Northampton, Mass. The committee having the banquet in charge worked hard to make this year's dinner excel all former efforts. It included Chairman Day and R. P. Benedict, T. F. Butterworth, F. C. Howard, C. S. Clark, E. N. Krone and J. J. Brennan. A fine musical program was given by the Easthampton Mandolin Club, the Easthampton Male Quartet and the Northampton Glee Club. Among the speakers and entertainers were the Mayor of Northampton, W. H. Feiker; Past National Presidents H. E. Stone and P. H. Hogan, State Vice-President A. M. Day and Jack Armour of "Power." Frank E. Davis was a most efficient toastmaster.

The following resolution by the American Museum of Safety trustees has been forwarded to President John H. Patterson, of the National Cash Register Co., Dayton, Ohio, in recognition of his heroic work among the flood sufferers: "Resolved, That the trustees of the American Museum of Safety by formal resolution desire to express their esteem and appreciation of the civic heroism and the unselfish devotion of John Henry Patterson, president, National Cash Register Co., one of the gold medalists of the Museum this year, in placing himself, his family, and his factory, unstintedly in the service of rescuing, sheltering, and feeding the afflicted in the great flood catastrophe overwhelming the city of Dayton. The trustees, furthermore, feel that this unselfish devotion and patriotic social service, typical of a long life devoted to social welfare, should not be accepted by the museum or the public in silence."

The annual meeting of the National Association of Cotton Manufacturers will be held at Boston, Mass., Wednesday and Thursday, Apr. 24 and 25, in Huntington Hall, Massachusetts Institute of Technology. The sessions will be called to order on Wednesday at 11 a.m. and 2:30 p.m., and on Thursday at 10:30 a.m. and 2:30 p.m. Governor Foss, a member of this association, and Richard C. Maclaurin, president of the Massachusetts Institute of Technology, have consented to give addresses of welcome. Senator John W. Weeks, an honorary member of the association, will also give an address if his duties permit him to leave Washington at the time. In addition to the opening address by President Edwin Farnham Greene, papers are expected on the following subjects among others: "Centralized Power Plants," "Economy in Lubrication," and "Economy of Superheated Steam."

OBITUARY

WILLIAM H. FLETCHER

William H. Fletcher, the vice-president of the W. & A. Fletcher Co., steamboat and steam yacht builders, and president of the Consolidated Iron Works, of Hoboken, who was a well known marine engineer, died Apr. 2 at his home, 777 West End. Ave., New York City. Mr. Fletcher was a member of many clubs and societies. He leaves a wife, one daughter and two sons.

PERSONALS

William Martin, for several years manager of the New York office of the Kennedy Valve Manufacturing Co., resigned that position on Apr. 1.

D. C. & William B. Jackson, the Boston consulting engineers for electric and allied properties, have moved from 84 State St. to 248 Boylston St., that city.

Frank Heimboldt, who for the past sixteen years has been chief electrician for the Prudential Insurance Co. at its home office in Newark, N. J., has accepted the position of superintendent of the Guaranty Trust Co. building, at Liberty St. and Broadway, New York City.

St. John (N. B.) Proposed Development

The New Brunswick (Canada) Hydroelectric Co. proposes to develop within 50 miles of St. John 15,000 to 20,000 hp. and transmit the current to the city to be used for light and power purposes. Legislation relative to street railways will result in an extension of the St. John Street Ry. system into the suburban districts, enabling the city to expand in these directions. This is considered important, as the present city is somewhat congested.

Cleveland Engineers Hold Smoker

On Saturday evening, Apr. 5, a smoker was held by National Association No. 5, of Cleveland, Ohio, at Elks Hall. About three hundred were present, including a large delegation from No. 47 of that city. Three of the national officers, James R. Coe, vice-president, Fred W. Raven, secretary, and Samuel B. Forse, treasurer, were in attendance, as well as R. G. Ingleson. Past President J. E. Radigan was the toastmaster.

Interesting addresses were made by the national officers and by F. R. Low, editor of "Power"; T. W. Roberts, past president of No. 47, and Mr. Osborn, president of the Central States Supplymen's Association.

The entertainment comprised numbers by Kenneth G. Merrill, William Murray, Fred Hickey, the Olmstead quartet and Jack Armour. A variety of refreshments was served. The committee included H. J. Baier, J. B. Lahiff, J. B. Clapper, E. E. Tindall, G. R. Henderson and Thomas Phillips.

Indiana Model Public-Utility Law

The Indiana public-utility law, which is effective after May 1, has been declared a model law in its clearness and practicability. The service commission created under this law will have five members, not more than three of whom will be of the same political party, and will be appointed by the governor for a term of four years. The duties of the former railroad commission are now assumed by the commission, which is authorized to employ such attorneys, engineers, examiners, experts, accountants, etc., as may be necessary.

Each public utility must furnish reasonably adequate service and facilities, and the charges shall be reasonable. Each must render to the commission uniform accounts of all business, and if engaged directly or indirectly in any other business shall make separate reports thereof if so ordered. The commission will prepare suitable blanks and forms for carrying out its purposes. No public utility shall keep any other books, accounts or records except those prescribed or approved by the commission, unless required by some other public authority.

Every public utility must carry an adequate depreciation account whenever the commission determines that it can be reasonably required. Depreciation charges shall be set aside out of the earnings and carried in a fund which may be expended either for new construction, extensions or additions to the property or may be invested; if invested, the income shall also be carried in the fund. This fund and its proceeds shall be used only for depreciation, and in no event shall the money expended from the fund for new construction be credited to the capital account, but it shall be charged against the depreciation fund.

No utility may charge or receive a greater or less compensation for any service performed by it than is specified in its public schedules. The commission shall provide for a comprehensive classification of the service rendered, which may take into account the quantity, the time, the purpose for which used and other reasonable considerations. The commission shall have authority to inquire into the management of all public utilities and obtain in any case all necessary information to enable it to perform its duties, including the right to inspect books, accounts, records, etc., and to examine under oath any officer or employee in relation to business affairs.

This commission is to have complete authority over the issues of stocks, bonds, notes and certificates of indebtedness by public-utility companies. No public utility shall issue any stock or certificate of stock except in consideration of money value, as found by the commission or at such premium as may be approved by it. When two or more corporations are merged the combined capitalization shall not exceed the sum of the capital stock of the corporations consolidated except for additional sums of cash actually paid out. No contract for consolidation or lease or merger shall be capitalized.

No license, permit or franchise will be granted to any interest to own, operate, manage or control any public utility in any municipality where one is already in operation and furnishes similar service under an indeterminate license, franchise or permit unless the commission has declared, after a public hearing, that the public interest requires a second utility and the resulting competition.

The act forbids any public utility to give free service, franks or special privileges to any patron or public officer, or to any political committee or candidate for public office. Violation of this provision is punishable by not less than one or more than five years' imprisonment, or by a fine of not less than $200 or more than $1000.

Rebates are declared unlawful. Violation of any of the provisions of the act by any officer or agent of a public utility is a misdemeanor and punishable by a fine.

The commission shall have the power to enforce the provisions of all other public-utility laws. A sum sufficient to carry out the provisions of the act, not to exceed $75,000, is appropriated annually out of the state treasury.

❖

NEW EQUIPMENT

ATLANTIC COAST STATES

Plans are being considered by the Beverly Gas & Electric Co., Beverly, Mass., for the improvement of its plant and extension of its system. A. Macauley is superintendent.

The city of Springfield, Mass., is considering plans for the construction of an electric-light plant to furnish light for the recently completed group of municipal buildings. John A. Dennison is mayor.

Preliminary arrangements are being made for the installation of an electric-light plant at Williams College, Williamstown, Mass., to furnish electricity for all the college buildings.

The Elmira Water, Light & R.R. Co. is preparing plans for the construction of a new power plant at Elmira, N Y. H. M. Beardsley is manager.

Permission has been granted to the Public Service Electric Co. to construct an addition to its power plant on Duffield Ave., Jersey City, N. J. Estimated cost, $80,000. Dudley Farrand, Newark, N. J., is general manager.

SOUTHERN STATES

Plans have been prepared for the construction of a municipal electric-light plant at Camden, S. C. Estimated cost, $35,000.

Bonds for $30,000 have been voted for the construction of a water-works system at McColl, S. C. J. R. Bivens is mayor.

The city of Atlanta, Ga., is considering plans for the installation of an electric-generating plant at the river pumping station. Estimated cost, $9500. R. M. Clayton is chief of the construction department and R. C. Turner is city engineer.

The Washington Ice Co., New Orleans, La., is building a two-story brick addition to its factory.

An election will be held Apr. 24 by the citizens of Dresden, Tenn, to vote on the proposition to issue $24,000 in bonds for the construction of an electric-light plant.

The construction of an electric-light plant at Gleason, Tenn., is under consideration.

The Nashville, Chattanooga & St. Louis R.R., of which Horace Smith, Nashville, Tenn., is general manager, will purchase boilers for a small power plant it is to install at Paducah, Ky., for the operation of a round-house and machine shop it has recently built there.

The Park City Mills, Bowling Green, Ky., will buy electric motors for the operation of the special equipment, having decided to convert from steam power to the electric drive. Address R. D. McReynolds.

Ice machinery will be needed by the Fayette National Bank, Lexington, Ky., for its new 15-story office building, which is now being erected.

CENTRAL STATES

The village of Lindsey, Ohio, is making preliminary arrangements for the construction of an electric-light plant.

The Rubber Co. of Norwood, Ohio, will install five new boilers and an automatic stoker in its plant. Estimated cost, $25,000.

Plans have been prepared for the improvement of the municipal electric-light plant and system at Goshen, Ind. Estimated cost, $30,000. Burns & McDonnell, Scarritt Bldg., Kansas City, Mo., are consulting engineers.

WEST OF THE MISSISSIPPI

The construction of new municipal electric-light plant at Windom, Minn., is under consideration.

Plans are being prepared for the construction of an electric-light plant at Interior, S. D.

A company is being organized at Oacoma, S. D., for the purpose of constructing an electric-light plant. J. E. Kennedy is interested in the project.

The commercial club of White, S. D., is taking steps toward the installation of an electric-light plant and water-works system.